

APPENDIX H

Laboratory QA Documentation Report

JOINT KENNECOTT UTAH COPPER DIVISION
MINE HYDROGEOLOGIC STUDY

Laboratory Quality Assurance
May 21, 1987

L. A. Hutchinson
Laboratory Director

J. C. Parr
Laboratory Quality Control Supervisor

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I. OVERVIEW OF LABORATORY QUALITY ASSURANCE

1986 laboratory quality assurance report

The Kennecott Environmental Laboratory received approximately 800 samples in connection with the joint Kennecott, State of Utah, and Salt Lake County Hydrogeologic Study at the Utah Copper Division mine. These samples were analyzed by EPA methodologies as outlined in the Joint Work Plan agreed upon by the study participants. All samples were collected and preserved by UCD field sampling personnel according to accepted EPA sampling protocol as outlined in EPA-600/4-79-020. Samples were delivered to the laboratory daily. Measurements made at the time of sampling included: pH, conductivity, temperature, carbonate, bicarbonate, and depth.

The laboratory analyzed the samples received for a portion or all of the following parameters as requested by the UCD field manager: total dissolved and suspended solids, fluoride, chloride, nitrate and nitrite nitrogen, sulfate, alkalinity, acidity, ortho-phosphate phosphorus, dissolved silica, hardness, phenol, total organic carbon, and coliform bacteria. The following metals were analyzed on both a total (digested) and dissolved (-0.45 micron filtered) fraction: aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, calcium, molybdenum, magnesium, potassium, sodium, selenium, silver, nickel, and zinc. Selected samples were sent to Controls for Environmental Pollution (CEP) Laboratory in New Mexico for determination of radionuclides.

The laboratory's routine quality assurance program was used to ensure the validity of the data reported from the laboratory. This included the review and evaluation of all analytical data prior to release of final reports, such as checks for clerical accuracy, consideration of historical trends, calculation of ionic balances and assessment of operational quality assurance information.

On site inspections and audits were preformed by Mr. Charles C. Walker and Ms. Ruth Orlob from the State Health Department, and by Mrs. Betty O'Shea representing the American Industrial Hygiene Association Laboratory Accreditation Committee.

The Laboratory continue to successfully participate in various round robin testing programs to ensure the quality of its work. These interlaboratory testing programs include samples from the EPA (NPDES and Drinking Water studies and those administered by the State of Utah); American Industrial Hygiene Association

(Proficiency of Analytical Testing); the Canadian Centre de Toxocologie du Quebec (Interlaboratory Comparison Program); College of American Pathologists (Proficiency Testing); the West Allis Memorial Hospital (Interlaboratory Test Program); and the Utah State University (SRI vegetation program).

In addition to the interlaboratory programs cited above, the following intralaboratory programs were used: National Bureau of Standards reference samples, Environmental Resources Association (ERA) standards, and EPA audit samples. Kennecott has a number of internal reference standards that have known values developed through round robin testing in the copper industry. These are also used regularly in laboratory tests.

Changes during the year have occurred in instrumentation, personnel, software and administration. Instrumentation changes include acquiring an ALPKEM Rapid flow Analyzer and Computer, and replacing one of the Perkin-Elmer Zeeman 5000 units and the 5000 Atomic Absorption Spectrometer with a fully equipped and automated Perkin-Elmer Zeeman 5100. Personnel changes were prompted by transfers and retirement. These resulted in the loss of one full time position. Software changes included the implementation of an historical review program (see appendix D). The retirement of Mr. A. P. Langheinrich has necessitated that Mr. L. A. Hutchinson become the Laboratory Director as well as the Laboratory Supervisor. Administratively the Laboratory is now a part of the Utah Copper Division resulting in more direct communication with the project supervisor.



STATE OF UTAH
DEPARTMENT OF HEALTH

NORMAN H. BANGERTER, GOVERNOR

SUZANNE DANDOY, M.D., M.P.H., EXECUTIVE DIRECTOR

April 28, 1986

Armin P. Langheinrich, Director
Kennebott Environmental Hygiene
Laboratory
Kennebott Corporation
1515 Mineral Square
Salt Lake City, Utah 84147

Dear Mr. Langheinrich:

Attached is a corrected copy of your laboratory's performance evaluation for 1986. I apologize for the previous clerical errors.

I have just submitted make-up audits for the parameters missed. I have also included an audit for Molybdenum.

If you have any questions, please feel free to call.

Sincerely,

A handwritten signature in black ink that reads "Charles C. Walker".

Charles C. Walker, Chemist
Quality Assurance Section
Bureau of Laboratory Improvement

AUDIT/SRM SAMPLE PREPARATION

LABORATORY: KENNECOTT CORPORATIONDATE: 2/13/86AUDIT
SAMPLE SRM

<u>PARAMETER</u>	<u>MADE</u>	<u>DELIVERED</u>	<u>RESULTS RETURNED</u>	<u>TRUE VALUE</u>	<u>REPORTED VALUE</u>	<u>ACCEPTABLE</u>	<u>COMMENTS</u>
		2-13-86	3-13-86				
NH ₃				1.52		1.34 - 1.70	
Nitrate				1.60	1.56	1.44 - 1.76	ACCEPTABLE
O-Phos				0.27	0.26	0.25 - 0.29	ACCEPTABLE
TKN				4.78		4.32 - 5.44	
T-Phos				1.03		0.94 - 1.18	
TOC				61.3	54.0	49.2 - 72.0	ACCEPTABLE
COD				145		119 - 159	
BOD				84.4	78.0	60.8 - 108	ACCEPTABLE
TSS				108	278.8	90.6 - 113	NOT ACCEPTABLE
TVS				45		34.1 - 53.3	
TDS				272	298.1	236 - 316	ACCEPTABLE
pH	1			5.7	5.64	5.58 - 5.82	ACCEPTABLE
	2			7.8	7.75	7.64 - 7.96	ACCEPTABLE
Ca				40.6	41	35.9 - 44.5	ACCEPTABLE
Mg				8.4	8.0	7.00 - 9.58	ACCEPTABLE
Na				46.5	47.0	41.5 - 50.3	ACCEPTABLE
K				9.8	10.0	8.43 - 11.6	ACCEPTABLE
T. Alk.				34.4	114	31.1 - 37.7	NOT ACCEPTABLE
SO ₄				95.3	95	83.5 - 103.3	ACCEPTABLE
C _l				80.8	76.6	75.5 - 86.3	ACCEPTABLE
F				1.3	1.39	1.16 - 1.44	ACCEPTABLE
T. Hard.				136	138	127 - 142	ACCEPTABLE
S. Cond.				552	500	506 - 598	NOT ACCEPTABLE
TDS			Conc. 1				
Ag				124	1.20	0.90 - 1.62	ACCEPTABLE
Tl				25.0	24.0	16.8 - 37.0	ACCEPTABLE

AUDIT/SRM SAMPLE PREPARATION

LABORATORY: KENNECOTT CORP.DATE: 2-13-86AUDIT
SAMPLE SRM

<u>PARAMETER</u>	<u>MADE</u>	<u>DELIVERED</u>	<u>RESULTS RETURNED</u>	<u>TRUE VALUE</u>	<u>REPORTED VALUE</u>	<u>ACCEPTABLE 95%</u>	<u>COMMENTS</u>
Al	1	2-13-86	3-13-86	107	135	88.9 - 182	ACCEPTABLE
	2			729	740	618 - 872	ACCEPTABLE
As	1			26.7	25	19.5 - 33.9	ACCEPTABLE
	2			235	230	182 - 286	ACCEPTABLE
Be	1			29.0	29	24.5 - 34.1	ACCEPTABLE
	2			235	240	207 - 257	ACCEPTABLE
Cd	1			9.1	10	6.7 - 10.8	ACCEPTABLE
	2			39.0	41	31.0 - 42.8	ACCEPTABLE
Cr	1			6.8	5	4.7 - 9.2	ACCEPTABLE
	2			261	265	209 - 306	ACCEPTABLE
Co	1			42.6	45	36.1 - 48.5	ACCEPTABLE
	2			261	260	229 - 289	ACCEPTABLE
Cu	1			8.9	9	6.1 - 13.1	ACCEPTABLE
	2			339	340	302 - 369	ACCEPTABLE
Fe	1			20.9	22	12.2 - 32.2	ACCEPTABLE
	2			797	770	695 - 882	ACCEPTABLE
Hg	1			0.67	0.6	0.3 - 1.1	ACCEPTABLE
	2			8.73	6.6	5.9 - 11.1	ACCEPTABLE
Pb	1			42.7	44	33.7 - 53.7	ACCEPTABLE
	2			435	440	369 - 492	ACCEPTABLE
Mn	1			12.9	13	8.2 - 17.2	ACCEPTABLE
	2			348	330	304 - 387	ACCEPTABLE
Ni	1			17.1	17	11.5 - 23.0	ACCEPTABLE
	2			207	210	177 - 235	ACCEPTABLE
Se	1			10.9	9	6.5 - 13.9	ACCEPTABLE
	2			50.2	40	31.5 - 62.4	ACCEPTABLE
V	1			129	125	99.9 - 160	ACCEPTABLE
	2			846	830	726 - 1002	ACCEPTABLE
Zn	1			9.8	10	3.6 - 17.8	ACCEPTABLE
	2			418	430	381 - 449	ACCEPTABLE

AUDIT/SRM SAMPLE PREPARATION

LABORATORY: KENNECOTT CORPORATION DATE: 2-13-86

AUDIT SAMPLE

SRM

<u>PARAMETER</u>	<u>MADE</u>	<u>DELIVERED</u>	<u>RESULTS RETURNED</u>	<u>TRUE VALUE</u>	<u>REPORTED VALUE</u>	<u>ACCEPTABLE</u>	<u>COMMENTS</u>
B		2-13-86	3-13-86	1.0 mg/L	0.97	.092 - 1.08	ACCEPTABLE
Ag	Conc. 1			1.0 mg/L	0.98	0.93 - 1.05	ACCEPTABLE
	2			6.00	5.90	4.74 - 7.04	ACCEPTABLE
Ba	Conc. 1			40.0	40.0	29.7 - 47.3	ACCEPTABLE
	2			119.6	110	94.2 - 144	ACCEPTABLE
Mo	Conc. 1			1.70 mg/L	<0.01	1.24 - 2.56	
	2			10.0	<0.01	9.9 - 13.8	



STATE OF UTAH
DEPARTMENT OF HEALTH

NORMAN H. BANGERTER, GOVERNOR

SUZANNE DANDOY, M.D., M.P.H., EXECUTIVE DIRECTOR

July 23, 1986

Armin P. Langheinrich, Director
Kennecott Environmental Hygiene
Laboratory
Kennecott Minerals, Company
1515 Minerals Square
Salt Lake City, Utah 84147

Certificate No.: E-24
Laboratory Class: I

Mr. Langheinrich:

Having been surveyed and found in compliance with the requirements for certification, the laboratory listed is hereby certified to perform tests in environmental chemistry for the parameters listed:

TRACE METALS

Aluminum
Arsenic
Barium
Beryllium
Boron
Cadmium
Chromium
Cobalt
Copper
Iron
Lead
Manganese
Mercury
Molybdenum
Nickel
Selenium
Silver
Thallium
Vanadium
Zinc

RESIDUE

Total Dissolved Solids (TDS)
Total Suspended Solids (TSS)
Total Volatile Solids (TVS)

MINERALS

Calcium
Chloride
Fluoride
Magnesium
pH
Potassium
Sodium
Specific Conductance
Sulfate
Total Alkalinity
Total Hardness

NUTRIENTS

Ammonia
Nitrate
Nitrite
Ortho-Phosphate
Total Phosphorus
Total Kjeldahl Nitrogen

DEMAND

Biochemical Oxygen Demand (BOD)
Chemical Oxygen Demand (COD)
Total Organic Carbon (TOC)

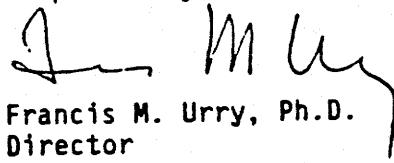
Armin P. Langheinrich
Page Two
July 23, 1986

MISCELLANEOUS

Cyanide
Oil and Grease
Phenol
Silica (SiO_2)

The effective date for this certificate is July 23, 1986. The parameters for which a laboratory is certified at any given time will be those indicated in the most recent certification letter. Copies of this letter will be on file in (1) the Bureau of Laboratory Improvement, State Health Laboratory and (2) the Division of Environmental Health. The certificate will be recalled in the event that your laboratory's certification is revoked.

Respectfully,


Francis M. Urry, Ph.D.
Director

cc: Calvin Sudweeks
Gayle Smith



rec'd
9/15/86

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 20 1986

Dear NPDES Permit Holder:

OFFICE OF
WATER

Thank you for participating in the 1986 National Discharge Monitoring Report (DMR) Quality Assurance (QA) Program, for all major permittees in the National Pollutant Discharge Elimination System (NPDES). Environmental Protection Agency's (EPA's) evaluation of the results submitted by your laboratory is enclosed. If this letter has not been directed to your laboratory, please provide a copy of the enclosed statistical evaluation to the laboratory which performed the analyses for you.

You will note that each value reported has been placed in one of four categories (acceptable, check for error, not acceptable, or unusable data). If one or more of your reported values is not acceptable, you should check for sources of errors. The purpose of this notice is to provide you with results, and if the data are not acceptable, to allow you to take voluntary remedial actions. You will also note that, "true"/calculated values are provided only for the constituents you reported. If you desire a complete list of "true"/calculated values, please contact your State or Regional Coordinator.

A list of steps for identifying data handling and analytical problems is enclosed. Please submit your corrective actions in writing to your State or Regional Coordinator within 45 days. Your response will be considered by EPA/State in determining need for further follow-up. Where sources of errors are not readily apparent, your laboratory should make a systematic examination of all related portions of its analytical method(s). Quality Control (QC) check samples may be requested for self-evaluation purposes by mailing the enclosed form to the Environmental Monitoring and Support Laboratory.

To ensure that your results and actions can be considered by the proper office, documentation of all corrective actions and use of QC check samples should be sent to your State or Regional Coordinator (as specified in the following page). Please refer to your NPDES permit number in all correspondence. On behalf of EPA and the involved State Agencies, thank you and your laboratory for your cooperation and participation in this QA Program.

Sincerely yours,


James R. Elder

James R. Elder, Director
Office of Water Enforcement and Permits

PERFORMANCE EVALUATION REPORT

DATE: 07/09/86

DMR-QA STUDY NUMBER 006

PERMITTEE: UT0024350

KENNECOTT UTAH COPPER DIVISION

IX

ANALYTES	V	REPORT P VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
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TRACE METALS IN MICROGRAMS PER LITER:

ALUMINUM	X	700	700	557.- 850.	594.- 813.	ACCEPTABLE
ARSENIC		180	191	131.- 244.	145.- 230.	ACCEPTABLE
BERYLLIUM	X	650	661	564.- 749.	588.- 725.	ACCEPTABLE
CADMIUM		120	119.3	105.- 134.	108.- 131.	ACCEPTABLE
CHROMIUM	X	800	686	534.- 826.	571.- 790.	CHECK FOR ERROR
COBALT	X	200	210	176.- 244.	184.- 235.	ACCEPTABLE
COPPER		750	749	657.- 830.	679.- 809.	ACCEPTABLE
IRON		650	633	538.- 722.	561.- 699.	ACCEPTABLE
LEAD		880	851	706.- 984.	740.- 949.	ACCEPTABLE
MANGANESE		150	150	129.- 169.	134.- 164.	ACCEPTABLE
MERCURY		15	15.0	10.1- 20.7	11.4- 19.4	ACCEPTABLE
NICKEL	X	800	911	791.-1030.	821.-1000.	CHECK FOR ERROR

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT

DATE: 07/09/86

DMR-2A STUDY NUMBER 006

PERMITTEE: UT0024350 KENNECOTT UTAH COPPER DIVISION

IX

ANALYTES	V	REPORT	TRUE	ACCEPTANCE	WARNING	PERFORMANCE
	P	VALUE	VALUE*	LIMITS	LIMITS	EVALUATION

TRACE METALS IN MICROGRAMS PER LITER:

SELENIUM	X	86	90.0	54.1- 109.	61.1- 102.	ACCEPTABLE
VANADIUM	X	660	650	511.- 778.	545.- 744.	ACCEPTABLE
ZINC		870	893	782.- 994.	809.- 967.	ACCEPTABLE

MISCELLANEOUS ANALYTES:

PH-UNITS		4.48	4.50	4.38- 4.59	4.41- 4.56	ACCEPTABLE
TOTAL SUSPENDED SOLIDS (IN MG/L)		62.6	65.2	50.8- 69.2	53.1- 66.9	ACCEPTABLE
OIL AND GREASE (IN MG/L)		10.1	11.0	3.88- 16.5	5.46- 14.9	ACCEPTABLE

NUTRIENTS IN MILLIGRAMS PER LITER:

NITRATE-NITROGEN	X	1.48	1.50	1.19- 1.79	1.26- 1.72	ACCEPTABLE
ORTHOPHOSPHATE	X	2.83	3.21	2.74- 3.66	2.85- 3.55	CHECK FOR ERROR

DEMANDS IN MILLIGRAMS PER LITER:

TOC	X	26	26.7	19.9- 33.3	21.6- 31.5	ACCEPTABLE
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* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT

DATE: 07/09/86

DMR-QA STUDY NUMBER 006

PERMITTEE: UT0024350

KENNECOTT UTAH COPPER DIVISION

IX

ANALYTES	V	REPORT	TRUE	ACCEPTANCE	WARNING	PERFORMANCE
	P	VALUE	VALUE*	LIMITS	LIMITS	EVALUATION

DEMANDS IN MILLIGRAMS PER LITER:

5-DAY BOD	40.7	44.4	27.4-	61.4	31.6-	57.2	ACCEPTABLE
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ADDITIONAL MISCELLANEOUS ANALYTES:

TOTAL CYANIDE (IN MG/L)	0.82	0.600	.343-	.807	.401-	.748	NOT ACCEPTABLE
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TOTAL PHENOLICS (IN MG/L)	X	0.46	0.518	.208-	.828	.286-	.750	ACCEPTABLE
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* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PAGE 3 (LAST PAGE)



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII

999 18th STREET—SUITE 500

DENVER, COLORADO 80202-2405

DEC 22 1986

Ref: 8ES-QA

Lynn Hutchinson, Lab Supt.
Kennebott Copper
1515 Mineral Square
Salt Lake City, Utah 84112

Re: DMRQA
Parameters: CN
Permittee No.: UT24350

Dear Ms. Hutchinson:

Results of your participation in the 1986 National Pollutant Discharge Elimination System Quality Assurance Program have been reviewed by EPA Region VIII.

Please note that your data has been placed in one of the three categories (Acceptable, Check For Error, or Not Acceptable). Please check your results for parameters rated as either "Check For Error" or "Not Acceptable" and within thirty (30) days of receipt of this letter provide a written explanation as to why you believe your results did not fall within the "Acceptable" range.

I strongly urge you to utilize the enclosed document titled "Quality Assurance Follow-up Checks" as you try to trace your source of error. Also enclosed is a form which you may use to order more quality control samples from EPA.

Sincerely,

A handwritten signature in black ink that reads "James B. Lehr".

James B. Lehr, Director
Environmental Services Division

Enclosures

cc: Carol Campbell - EPA, Denver

Kennecott
Engineering/Construction
1515 Mineral Square
P.O. Box 11248
Salt Lake City, Utah 84147
Telex II: 910-925-5969

LAH

Kennecot¹

January 8, 1987

Mr. James B. Lehr, Director
Environmental Services Division
EPA Region VIII
999-18th Street, Suite 500
Denver, CO 80202-2405

Reference: DMR-QA Study #006
Permittee No: Ut-51 & Ut-24350
Parameters: CN, Ni

Dear Mr. Lehr:

Item #1. I am Mr. Lynn Hutchinson

Item #2. "Not Acceptable" Cyanide results

The "Not Acceptable" Cyanide results were investigated and corrected in early September when we received the DMR-QA Study #006 results. The error was traced to a bad stock cyanide standard used, and the high cyanide result was missed in our internal quality control because the level of the DMR-QA sample was over 100 times higher than the level of cyanide seen in our routine work.

Corrective steps include more frequent replacement of stock standard and expansion of internal QC/QA to cover higher ranges of cyanide concentrations.

Item #3. "Check for Error" Nickel result.

Careful review of all quality assurance data for this nickel value failed to identify any specific problem. All nickel control values were within acceptable limits.

Corrective measures include additional QA samples and increased blind replicate analysis.

LAH/3

James B. Lear

-2-

January 8, 1987

Problems noted in your letter of December 22 were reviewed with the State of Utah, Department of Health, Laboratory Improvement Section personnel shortly after receipt of our results in September 1986.

If you need additional information, please let me know.

Sincerely,

Lynn A. Hutchinson
Lynn A. Hutchinson
Laboratory Supervisor

LAH/jb

cc: Carol Campbell, EPA Region III Denver
A. P. Langheinrich

P.S. You might want to review your "Quality Assurance Follow-up checks" sheets, for types (e.g. paragraph 4, Standard Titrating Reagents, norality).

LAH/3



Norman H. Bangerter
Governor

Suzanne Dandoy, M.D., M.P.H.
Executive Director

February 3, 1987

Armin P. Langheinrich, Director
Kennebott Corporation
1515 Mineral Square
Salt Lake City, Utah 84147

Dear Mr. Langheinrich:

This is an official notification that your laboratory has been requested to be included on the list of recipients of EPA's Water Pollution and Water Supply Study Audits. Your laboratory reporting code for these audits is UT019.

The data you submit for these audits will be used to update your certification status. If data is not submitted within the indicated deadline or if data for particular parameters is omitted from the audits, there will be no evaluation of the audits or parameters omitted, your certification status will be correspondingly updated to reflect the extent of your participation in the audits.

If there are parameters that are not contained on these audits that you wish to have included on your certificate, you need to make arrangements with me to analyze a performance sample for additional parameters.

I recommend that you fully and completely analyze all even audits (i.e. WS020/WP018) and use the odd audits (i.e. WS021/WP019) as make-up audits for parameters that were either omitted or found to be unacceptable on the even audits.

If you have any questions or concerns, please do not hesitate to write or call.

Sincerely,

Charles C. Walker

Charles C. Walker, Chemist
Quality Assurance Section
Bureau of Laboratory Improvement

Kennecott
Technology
1515 Mineral Square 84112
P.O. Box 11248 84147
Salt Lake City, Utah
Telex II: 910-925-5969

Kennecott

February 27, 1987

Charles C. Walker, Chemist
Quality Assurance Section
Bureau of Laboratory Improvement
State Health Laboratory
44 Medical Drive
Salt Lake City, Utah 84113

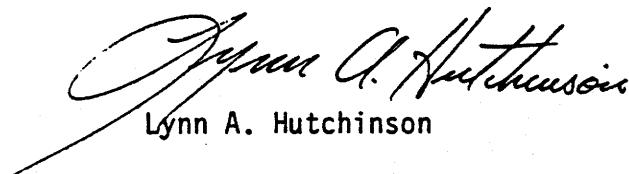
Reference: Kennecott Environmental Laboratory
Certification E-24

Dear Mr. Walker,

Mr. Armin Langheinrich will retire from Kennecott on March 1, 1987. As of that date I will assume the responsibilities of Laboratory Director for the Kennecott Environmental Laboratory. Please make the necessary changes in your records and direct future correspondence to my attention. Required curriculum vital information is contained in the certification application now on file in your office.

Thank you for your assistance.

Sincerely,



Lynn A. Hutchinson

LAH/ca

LAH1/w

III. SAMPLING AND CHAIN OF CUSTODY

Samples are collected by UCD field personnel. Field sample record sheets and appropriate sample preservations are done at the time of sampling. The water samples are kept refrigerated. Information collected at the time of sampling includes the pH, conductivity, temperature, depth to water, and carbonate and bicarbonate titration values. All of the above information plus the description, and the requested analysis are entered onto the "Laboratory Analytical Request Form." The samples and the analytical request forms are picked up daily at the UCD Environmental Field office by laboratory personnel and delivered directly to the sample receiving station at the laboratory.

Samples are immediately logged in as they arrive at the laboratory and assigned unique computer identification codes and laboratory control numbers. As soon as the samples have been coded and tagged they are delivered to the respective areas of analysis for those parameters which must be started immediately. Refrigerated storage of samples is provided where required under EPA guidelines.

Laboratory personnel receive updated computerized work assignment sheets regularly, which list all required analyses. They maintain personal record books to record all pertinent information related to their work. Upon completion of the analysis, the results are entered into the computerized record keeping system.

IV. ANALYTICAL PROCEDURES

All analytical procedures used for the analysis of these waters follow the EPA "Methods of Chemical Analysis of Water and Wastes" (EPA-600/4-79-020) and "Standard Methods for the Examination of Water and Wastewater" 16th Edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985.

V. QUALITY ASSURANCE PROCEDURES

Following EPA recommendations, sample splits, spikes, and standards are included on every run. In addition, the analyst himself includes known standards in every set of samples to ensure that he is within control limits. Examples of various control charts are given in Appendices B and C.

When all requested results have been entered into the computer, a final report is generated. Before this report is released the following quality assurance checks are made:

1. Laboratory final water reports are reviewed by the supervisor for proper description, correct data entry and any other possible types of computer or data entry error.
2. Ionic balances are done on "drinking water quality" waters.
3. Samples are verified against quality assurance work performed during the same analysis schedule.
4. Specific parameters are checked against historical records to identify outliers or unexpected large changes.

Laboratory procedures, methods, instrumentation, and quality assurance efforts were reviewed regularly with personnel from the Utah State Health Department, Standard Oil's Warrensville Laboratory and other independent laboratories. Major instrumentation was maintained under service contract with manufacturers' service departments. Standard materials were obtained from commercial vendors, EPA, and NBS.

Training has been conducted by manufacturers for operation of the new equipment. Instrumentation specialist Randy Hergenrader of Perkin-Elmer conducted an intensive three day course. The course covered operation and optimization for the ICP 6500, the HGA 5000, and data handling and computer operation. A one week training course on operation of the ALPKEM rapid flow analyzer system was completed by J. C. Parr.

Appendices-Table of Contents

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- B. Outlier and Data Control Chart Explanation
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- C. Ionic Balance Explanation
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- D. Historical Data Review Explanation
 - Historical Data Review Sheet 8621101
- E. X-Bar (Average Value) and R (Range) Charts
 - Selenium for Overflow Control Sample
 - Selenium for LAH Control Sample
 - Lead for Overflow Control Sample
 - Lead for LAH Control Sample
 - Copper for LAH Control Sample
 - Arsenic for Overflow Control Sample
 - Arsenic for LAH Control Sample
 - Aluminum for Overflow Control Sample
 - Aluminum for LAH Control Sample
- F. EPA Duplicate and Spike Chart for Chromium

The Kennecott Drill Hole Water System is a computer program which is used to flag outlier data points, calculate an ionic balance, and display historical data pertaining to the well monitoring system in conjunction with the Mine Hydrogeologic Study. The next page displays a copy of the menu screen from which this is accomplished. The first section deals with the limits which are used to assess outlier data points. Calculating the limits and locking them in place is done at least on an annual basis. It should be noted that if less than 6 data points are in the data base, this is done by limiting the variance to 15 % of the mean value of all points. Otherwise it is done by fitting the data to a normal distribution and eliminating any outliers three successive times. Three times the standard deviation is then used for rejection criteria. The second section deals with printed reports. The first choice is the ionic balance and outlier report. The second choice is a listing of the limits. The third choice is a listing of the historical data together with the current analytical results. The fourth is a plot of the data. The Third section is for displaying data on the screen of the terminal. The Fourth option is to exit the system. It is necessary to specify the sheet or sheet numbers to be checked. At this time the option to only display specified drill holes is not operational. In normal operation a single sheet number is entered in both the starting and ending sheet number and option I is normally used. all other parameters are defaulted.

KENNECOTT DRILL HOLE WATER SYSTEM MENU
LIMITS

- A. CALCULATE STATISTICS FROM HISTORICAL DATA
(CONTACT COMPUTING CENTER BEFORE USING)
- B. CHANGE STD DEV FACTOR FOR LIMITS
- C. CHANGE AND LOCK LIMITS FOR GIVEN ELEMENT

PAPER REPORTS

- I. BALANCE & LIMIT CHECK REPORT
- J. LIMIT REPORT LISTING
- K. HISTORICAL DATA REPORT
- L. PLOTS OF DATA

SCREEN DISPLAYS

- R. STATITICAL DATA SCREEN DISPLAY
- S. LIMIT DATA SCREEN DISPLAY
- T. HISTORICAL DATA SCREEN DISPLAY
- U. VSAM SCREEN DISPLAY-----FOR CICS ONLY

OTHER (USE ONLY AT END OF SESSION)

Z. TO TERMINATE

SELECT OPTION, PRESS ENTER I

ENTER START SHEET NUMBER FOR CHECK REPORT (YYDDDXX) 8625402

ENTER END SHEET NUMBER FOR CHECK REPORT (YYDDDXX) 8625402

TO RESTRICT OUTPUT, ENTER SPECIFIC HOLE NO., ELSE LEAVE BLANK

#DHL1 ----- #DHL2 ----- #DHL3 -----

#DHL4 ----- #DHL5 ----- #DHL6 -----

ENTER SAMPLE SIZE TO USE AVERAGE FOR LIMITS XX (X) 6

ENTER PERCENT OF AVERAGE TO USE FOR LIMITS WHEN

HISTORICAL SAMPLE SIZE IS LESS THEN ABOVE (.XX) .15

DO YOU WANT TO WRITE JUST OUT-OF-LIMIT DATA (Y/N) Y

DO YOU WANT TO WRITE HISTORICAL DATA POINTS (Y/N) N

PRESS KEY PF1 FOR MENU, ENTER TO CONTINUE

The Outlier and data control chart lists the following data: #MOUT; this column is either blank or contains the word out if the programs has determined the parameter value to be an outlier. #ELM, this is the symbol for the parameter measured. If an element is measured the chemical symbol for the element is displayed; other parameters are designated by appropriate symbolic nomenclature. #RESULT; this column displays the numeric value found for the parameter in question. #AVG3; this column displays the average value found after fitting the data to the normal distribution three times and rejecting outliers. The next two columns display the LOWER AND UPPER LIMITS as calculated by the program. These limits are calculated by multiplying the locking factor times the standard deviation and adding to or subtracting from the mean, or as explained for the column labeled #MAVG. #1; this column displays the number of original data points in the data base. #3; this column displays the number of data points after the three fits to the normal distribution. The next two columns display the minimum and maximum data points in the data base this is designated by #MIN1 and #MAX1. The next column, #MAVG; displays the means of obtaining the limits, a MAX indicates that the calculated limit exceeded the maximum value, so the maximum is taken as the upper limit; a MIN likewise indicates that the calculated value is less than the minimum value so that the minimum is used as the lower limit; a MN-MX indicates that both of the previous conditions have occurred. L-AVG indicates that the limit is calculated from the Lock Factor. The Lock factor is a factor which is multiplied times the standard deviation to set the limits. #STD3 is the column that shows the calculated standard deviation after the outliers have been eliminated. #CV3; this is the Coefficient of Variation after elimination of the outliers. Each sample on the sheet is started with a header line giving the sheet number, the drill hole identification, the sample type (D for dissolved or T for total), the average low limit of data points and the % of the average which causes a warning to print.

LIMITS REPORT. ROUTE TO L. HUTCHINSON									
#MOUT	#ELM	#RESULT	#AVG3	LOWER LIMIT	UPPER LIMIT	#N3	#MIN1	#MAX1	#MAVG
SHEET#= 8621101 LAB#=									
OUT NA	57.	604953 DRILL HOLE= VWW328 T TYPE= T	85.545	8	7	57.000	318.000	% = .15	1.2
OUT CA	140.	75.143	64.740	200.704	7	7	105.000	230.000	1.2
OUT MG	32.	154.571	168.438	47.000	8	8	32.000	47.000 MAX	1.2
OUT K	4.0	42.000	35.982	9.430	4	4	4.000	19.000 L-AVG	1.2
OUT F	0.10	8.200	6.970	0.100	0.120	3	0.100	0.120 MN-MX	1.2
OUT NO3-N	3.54	179.000	164.289	3.334	7	7	0.850	3.540	1.2
OUT S04	.01	0.010	0.010	0.010	0.010	6	1.62.000	196.000	1.2
FH0H									12.259
ALK	226	212.667	180.766	236.000	3	3	176.000	236.000 MAX	1.2
OUT HD	388	479.667	407.716	551.614	3	3	388.000	561.000 L-AVG	1.2
OUT FH	7.2	7.175	6.957	7.300	8	8	6.750	7.300 MAX	1.2
OUT HC03		252.500	245.000	260.000	2	2	245.000	260.000 MN-MX	1.2
COND	1570	1305.000	983.453	1570.000	8	8	800.000	1570.000 MAX	1.2
OUT CO3		0.500	0.425	0.575	2	2	0.000	1.000 L-AVG	1.2
TOC	4.5	4.500	4.500	4.500	1	1	4.500	4.500 MN-MX	1.2
TDS	886	899.875	854.000	946.281	8	8	854.000	981.000 MIN	1.2
CL	206	207.250	198.000	219.466	8	8	198.000	227.000 MIN	1.2
OUT TSS	0.9	0.700	0.595	0.805	3	3	0.200	1.000 L-AVG	1.2
OUT NO2-N	0.0	0.020	0.017	0.023	5	5	0.000	0.040 L-AVG	1.2
									0.436 62.277
									0.014 70.771
SHEET#= 8621101 LAB#=									
AS	0.004	0.004	0.004	0.004	8	8	0.004	0.004 MN-MX	1.2
BA	0.3	0.300	0.300	0.300	8	8	0.300	0.300 MN-MX	1.2
CD	0.005	0.007	0.005	0.005	8	8	0.005	0.010 MIN	1.2
CR	.01	0.010	0.010	0.010	8	7	0.010	0.020 MIN	1.2
PB	0.01	0.010	0.010	0.010	8	8	0.010	0.010 MN-MX	1.2
FE	0.09	0.030	0.010	0.010	8	7	0.010	0.120 MIN	1.2
MN	0.01	0.010	0.010	0.010	8	7	0.010	0.050 MIN	1.2
AL	.1	0.100	0.100	0.115	7	6	0.100	0.200 MIN	1.2
OUT MO	0.3	0.400	0.340	0.460	3	3	0.100	0.860 L-AVG	1.2
OUT NI	0.02	0.011	0.010	0.015	8	7	0.010	0.040 MIN	1.2
CU	0.01	0.015	0.010	0.020	8	8	0.010	0.020 MN-MX	1.2
ZN	0.01	0.053	0.010	0.106	8	8	0.010	0.130 MIN	1.2
AG	0.01	0.010	0.010	0.010	8	9	0.010	0.010 MN-MX	1.2
SE	0.004	0.004	0.004	0.004	8	6	0.004	0.004 MN-MX	1.2
BE	0.005	0.005	0.005	0.005	4	4	0.005	0.005 MN-MX	1.2
									0.000 0.000
SHEET#= 8621101 LAB#=									
NA	66.	72.500	66.000	79.000	2	2	64.000	79.000 MN-MX	1.2
CA	125.	140.000	125.000	155.000	2	2	125.000	155.000 MN-MX	1.2
MG	28.	35.000	29.750	40.250	2	2	28.000	42.000 L-AVG	1.2
K	4.0	4.000	4.000	4.000	1	1	4.000	4.000 MN-MX	1.2
F	0.10	0.100	0.100	0.100	1	1	0.100	0.100 MN-MX	1.2
OUT NO3-N	3.45	2.970	2.524	3.415	2	2	2.490	3.450 L-AVG	1.2
S04	176	183.500	176.600	191.000	2	2	176.000	191.000 MN-MX	1.2
FH0H	.01	0.010	0.010	0.010	2	2	0.010	0.010 MN-MX	1.2
ALK	240	240.000	240.000	240.000	1	1	240.000	240.000 MN-MX	1.2
HD	299	299.000	299.000	299.000	1	1	299.000	299.000 MN-MX	1.2
FH	7.4	7.350	7.300	7.400	2	2	7.360	7.400 MN-MX	1.2
COND	1350	1315.000	1280.000	1350.000	2	2	1280.000	1350.000 MN-MX	1.2
TOC	2.9	2.900	2.900	2.900	1	1	2.900	2.900 MN-MX	1.2
TDS	815	819.000	815.000	823.000	2	2	815.000	823.000 MN-MX	1.2
CL	155	160.500	155.000	166.000	2	2	155.000	166.000 MN-MX	1.2
TSS	17.2	17.200	17.200	17.200	1	1	17.200	17.200 MN-MX	1.2

LIMITS REPORT. ROUTE TO L. HUTCHINSON									
#HOUR #ELM	#RESULT	#AVG3	LOWER LIMIT	UPPER LIMIT	#AVG1	#MIN1	#MAX1	#AVG	#CV3
OUT NO2-N 0.01	0.015	0.012	0.017	2	2	0.010	0.020	L-AVG	1.2
SHEET#= 8621101 L-ELM#=	604956 DRILL HOLE= VWW397 D TYPE= D AVG LIM N = 6 AVG %= .15	0.004	0.004	2	2	0.004	0.004	MN-MX	1.2
AS 0.064	0.004	0.300	0.300	2	2	0.300	0.300	MN-MX	1.2
BA 0.3	0.005	0.005	0.005	2	2	0.005	0.005	MN-MX	1.2
CD 0.005	0.010	0.010	0.010	2	2	0.010	0.010	MN-MX	1.2
CR .01	0.010	0.010	0.010	2	2	0.010	0.010	MN-MX	1.2
FR 0.01	0.010	0.010	0.010	2	2	0.010	0.010	MN-MX	1.2
OUT FE 0.01	0.025	0.021	0.028	2	2	0.010	0.040	L-AVG	1.2
MN 0.01	0.010	0.010	0.010	2	2	0.010	0.010	MN-MX	1.2
AL .1	0.100	0.100	0.100	2	2	0.100	0.100	MN-MX	1.2
MO 0.1	0.100	0.100	0.100	1	1	0.100	0.100	MN-MX	1.2
NJ 0.01	0.010	0.010	0.010	2	2	0.010	0.010	MN-MX	1.2
OUT CU 0.05	0.050	0.051	0.069	2	2	0.050	0.070	L-AVG	1.2
OUT ZN 0.06	0.045	0.038	0.051	2	2	0.030	0.060	L-AVG	1.2
AG 0.01	0.010	0.010	0.010	2	2	0.010	0.010	MN-MX	1.2
SE 0.004	0.004	0.004	0.004	2	2	0.004	0.004	MN-MX	1.2
BE 0.005	0.005	0.005	0.005	1	1	0.005	0.005	MN-MX	1.2
SHEET#= 8621101 L-ELM#=	604957 DRILL HOLE= VWW396 T TYPE= T AVG LIM N = 6 AVG %= .15	58.650	79.350	3	3	53.000	84.000	L-AVG	1.2
OUT NA 53.	69.000	136.283	184.393	3	3	136.000	185.000	L-AVG	1.2
CA 160.	160.333	41.333	36.000	47.533	3	36.000	48.000	MN	1.2
MG 36.	4.0	4.000	4.000	4.000	1	4.000	4.000	MN-MX	1.2
K 0.10	0.100	0.100	0.100	0.100	1	0.100	0.100	MN-MX	1.2
F 3.88	3.017	2.564	3.469	3	3	2.140	3.880	L-AVG	1.2
NO3-N S04 124	119.333	113.000	124.000	124.000	3	113.000	124.000	MN-MX	1.2
PHOH .01	0.010	0.010	0.010	0.010	3	0.010	0.010	MN-MX	1.2
ALK 242	242.000	242.000	242.000	242.000	1	242.000	242.000	MN-MX	1.2
HD 390	390.000	390.000	390.000	390.000	1	390.000	390.000	MN-MX	1.2
PH 7.5	7.533	7.500	7.600	7.600	3	7.500	7.600	MN-MX	1.2
COND 1400	1441.667	1400.000	1500.000	1500.000	3	1400.000	1500.000	MN-MX	1.2
TOC 5.3	5.300	5.300	5.300	5.300	1	5.300	5.300	MN-MX	1.2
TDS 933	917.000	890.000	933.000	933.000	3	890.000	933.000	MN-MX	1.2
CL 250	243.000	237.000	250.000	250.000	3	237.000	250.000	MN-MX	1.2
TSS 4.4	4.400	4.400	4.400	4.400	1	4.400	4.400	MN-MX	1.2
OUT NO2-N 0.01	0.023	0.019	0.026	0.019	3	0.010	0.040	L-AVG	1.2
SHEET#= 8621101 L-ELM#=	604958 DRILL HOLE= VWW398 D TYPE= D AVG LIM N = 6 AVG %= .15	0.004	0.005	3	3	0.004	0.004	MN	1.2
AS 0.004	0.004	0.300	0.300	0.300	3	0.300	0.300	MN-MX	1.2
BA 0.3	0.005	0.005	0.005	0.005	3	0.005	0.005	MN-MX	1.2
CD 0.005	0.010	0.010	0.010	0.010	3	0.010	0.010	MN-MX	1.2
CR .01	0.010	0.010	0.010	0.010	3	0.010	0.010	MN-MX	1.2
PB 0.01	0.057	0.048	0.065	0.065	3	0.020	0.100	L-AVG	1.2
OUT FE 0.02	0.013	0.011	0.015	0.015	3	0.010	0.020	L-AVG	1.2
OUT MN 0.01	0.100	0.100	0.100	0.100	3	0.100	0.100	MN-MX	1.2
AL .1	0.100	0.100	0.100	0.100	1	0.100	0.100	MN-MX	1.2
MO 0.1	0.010	0.010	0.010	0.010	3	0.010	0.010	MN-MX	1.2
NJ 0.01	0.013	0.011	0.015	0.015	3	0.010	0.010	MN-MX	1.2
OUT CU 0.01	0.027	0.022	0.030	0.030	3	0.010	0.050	L-AVG	1.2
OUT ZN 0.05	0.010	0.010	0.019	0.019	3	0.010	0.010	MN-MX	1.2
AG 0.01	0.004	0.004	0.004	0.004	3	0.004	0.004	MN-MX	1.2
SE 0.004	0.005	0.005	0.005	0.005	2	0.005	0.005	MN-MX	1.2

The Ionic Balance portion of the program converts major parameters into milliequivalents per liter and totals the cations and anions. Thus comparison of total milliequivalents of anions and cations can be easily made. It should be noted that the ionic balance program has been modified to include all major parameters including those not normally found in the contaminated zones. A further feature of the program is that it accumulates the mg/l found of the major parameters and compares this to the total dissolved solids measurement. For rough comparison the specific conductivity of the sample is also printed. The format is to print first the total mg/l of major parameters. This is followed by a print of the measured total dissolved solids (TDS). The percent of the TDS represented by the total of the measured parameters is then printed. Next the sheet number, laboratory number and well description are printed. The milliequivalent data are then listed with the cations in the two right hand columns and the anions in the left column. The total milliequivalents are then printed at the bottom followed by the specific conductivity. On the page used as an example the balances look to be poor. No measurement of the carbonate and bicarbonate content of these particular samples was made which leaves the anion total short.

18MAY 1987 14:03:43.0 BALANCE REPORT. ROUTE TO L. HUTCHINSON

TOTAL= 681.04 TDS= 885.00 % OF TDS= 76.00 SHEET# 8621101 LAB# 604953 DESCRIPTION= VWW328 860729T
MILLIEQUIVALENTS

CATIONS--		ANIONS--	
CA	6.99	CU	0.00
MG	2.63	FE	0.04
K	0.10	MN	0.00
NA	2.48	ZN	0.01
		AL	0.01
		NI	0.00
		TOTAL	12.26
			TOTAL
			9.60
			CONDUCTIVITY= 15.70

TOTAL= 628.85 TDS= 815.00 % OF TDS= 77.00 SHEET# 8621101 LAB# 604955 DESCRIPTION= VWW397 860729T
MILLIEQUIVALENTS

CATIONS--		ANIONS--	
CA	6.24	CU	0.00
MG	2.30	FE	0.01
K	0.10	MN	0.00
NA	2.87	ZN	0.00
		AL	0.01
		NI	0.00
		TOTAL	11.53
			TOTAL
			8.09
			CONDUCTIVITY= 13.50

TOTAL= 696.22 TDS= 933.00 % OF TDS= 74.00 SHEET# 8621101 LAB# 604957 DESCRIPTION= VWW398 860729T
MILLIEQUIVALENTS

CATIONS--		ANIONS--	
CA	7.98	CU	0.00
MG	2.96	FE	0.01
K	0.10	MN	0.00
NA	2.31	ZN	0.01
		AL	0.01
		NI	0.00
		TOTAL	13.38
			TOTAL
			9.69
			CONDUCTIVITY= 14.00

The historical report is on two lines for each parameter. On the first line is listed the sheet number, the lab number, the drill hole description, the sample type designation (T for total or D for dissolved), the element and the result of the present sample. The second line has the historical data from first to last chronologically.

18MAY 1987 14:03:33.6 HISTORY REPORT. ROUTE TO L. HUTCHINSON

SHEET#	8621101 LAB#	HIS	75	77	57.	604953 DRILL HOLE VWW328 T ELM= NA	RESULT=	57.
SHEET#	8621101 LAB#	HIS	230	142	140.	604953 DRILL HOLE VWW328 T ELM= CA	RESULT=	140.
SHEET#	8621101 LAB#	HIS	38	45	45	604953 DRILL HOLE VWW328 T ELM= MG	RESULT=	32.
SHEET#	8621101 LAB#	HIS	19	5.0	4.0	604953 DRILL HOLE VWW328 T ELM= K	RESULT=	4.0
SHEET#	8621101 LAB#	HIS	0.1	.12	.10	604953 DRILL HOLE VWW328 T ELM= F	RESULT=	0.10
SHEET#	8621101 LAB#	HIS	1.66	.83		604953 DRILL HOLE VWW328 T ELM= NO3-N	RESULT=	3.54
SHEET#	8621101 LAB#	HIS	162	176	169	604953 DRILL HOLE VWW328 T ELM= SD4	RESULT=	179
SHEET#	8621101 LAB#	HIS	0.01	.01	.01	604953 DRILL HOLE VWW328 T ELM= PH0H	RESULT=	.01
SHEET#	8621101 LAB#	HIS	236	176	226	604953 DRILL HOLE VWW328 T ELM= ALK	RESULT=	226
SHEET#	8621101 LAB#	HIS	561	490	388	604953 DRILL HOLE VWW328 T ELM= HD	RESULT=	388
SHEET#	8621101 LAB#	HIS	7.15	6.75	7.3	604953 DRILL HOLE VWW328 T ELM= FH	RESULT=	7.2
SHEET#	8621101 LAB#	HIS	245	260		604953 DRILL HOLE VWW328 T ELM= HC03	RESULT=	
SHEET#	8621101 LAB#	HIS	800	975	1425	604953 DRILL HOLE VWW328 T ELM= COND	RESULT=	1570
SHEET#	8621101 LAB#	HIS	1	0		604953 DRILL HOLE VWW328 T ELM= TDS	RESULT=	1425
SHEET#	8621101 LAB#	HIS		4.5		604953 DRILL HOLE VWW328 T ELM= TOC	RESULT=	4.5
SHEET#	8621101 LAB#	HIS	981	881	854	604953 DRILL HOLE VWW328 T ELM= TDS	RESULT=	886
SHEET#	8621101 LAB#	HIS	227	218	203	604953 DRILL HOLE VWW328 T ELM= CL	RESULT=	206
SHEET#	8621101 LAB#	HIS	1	0.2	0.9	604953 DRILL HOLE VWW328 T ELM= TSS	RESULT=	0.9
SHEET#	8621101 LAB#	HIS	0.0	0.02	0.04	604953 DRILL HOLE VWW328 T ELM= NO2-N	RESULT=	0.0
SHEET#	8621101 LAB#	HIS				604954 DRILL HOLE VWW328 D ELM= AS	RESULT=	0.004

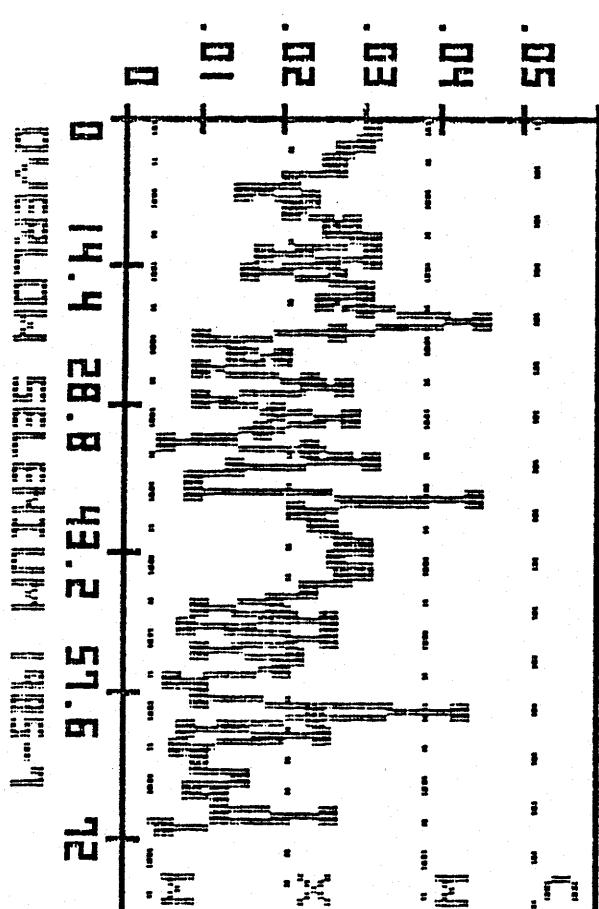
18MAY 1987 14:03:47.0 HISTORY REPORT. ROUTE TO L. HUTCHINSON

HIS 3.45 2.49

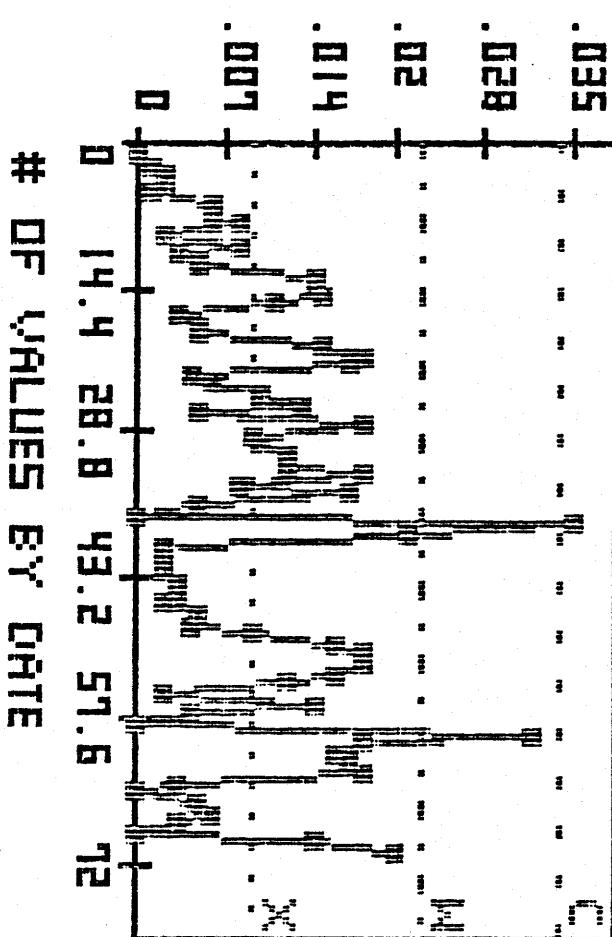
SHEET#	LAB#	DRILL HOLE VWW397 T ELM= SOA	RESULT=
HIS 176 191	8621101 LAB# .01	604955 DRILL HOLE VWW397 T ELM= PHOH	RESULT= .01
HIS 240	8621101 LAB# 7.4 7.3	604955 DRILL HOLE VWW397 T ELM= ALK	RESULT= 240
HIS 299	8621101 LAB# 1350 12B0	604955 DRILL HOLE VWW397 T ELM= HD	RESULT= 299
HIS 2.9	8621101 LAB# 815 823	604955 DRILL HOLE VWW397 T ELM= PH	RESULT= 7.4
HIS 155 166	8621101 LAB# 0.61 0.62	604955 DRILL HOLE VWW397 T ELM= COND	RESULT= 1350
HIS 17.2	8621101 LAB# 0.004 0.004	604955 DRILL HOLE VWW397 T ELM= TOC	RESULT= 2.9
HIS 155 166	8621101 LAB# 0.3 .3	604955 DRILL HOLE VWW397 T ELM= TDS	RESULT= 815
HIS 0.005 0.005	8621101 LAB# .01 .01	604955 DRILL HOLE VWW397 T ELM= CL	RESULT= 155
HIS .01 .01	8621101 LAB# 0.01 0.04	604956 DRILL HOLE VWW397 D ELM= TSS	RESULT= 17.2
HIS 0.01 0.01	8621101 LAB# .01 .01	604956 DRILL HOLE VWW397 T ELM= NO2-N	RESULT= 0.01
HIS 0.004 0.004	8621101 LAB# 0.01 0.04	604956 DRILL HOLE VWW397 D ELM= AS	RESULT= 0.004
HIS 0.01 0.01	8621101 LAB# .01 .01	604956 DRILL HOLE VWW397 D ELM= BA	RESULT= 0.3
HIS 0.005 0.005	8621101 LAB# .01 .01	604956 DRILL HOLE VWW397 D ELM= CD	RESULT= 0.005
HIS 0.01 0.01	8621101 LAB# .01 .01	604956 DRILL HOLE VWW397 D ELM= CR	RESULT= .01
HIS 0.01 0.01	8621101 LAB# .01 .01	604956 DRILL HOLE VWW397 D ELM= PB	RESULT= 0.01
HIS 0.01 0.01	8621101 LAB# .01 .01	604956 DRILL HOLE VWW397 D ELM= FE	RESULT= 0.01
HIS 0.01 0.01	8621101 LAB# .01 .01	604956 DRILL HOLE VWW397 D ELM= MN	RESULT= 0.01
HIS .1 .1	8621101 LAB# .01 .01	604956 DRILL HOLE VWW397 D ELM= AL	RESULT= .1
HIS .1 .1	8621101 LAB# .01 .01	604956 DRILL HOLE VWW397 D ELM= MO	RESULT= 0.1

HIS 0.1 18MAY 1987 14:03:49.1 HISTORY REPORT. ROUTE TO L. HUTCHINSON
 SHEET# 8621101 LAB# 604956 DRILL HOLE VWW397 D ELM= NI RESULT= 0.01
 HIS 0.01 0.01
 SHEET# 8621101 LAB# 604956 DRILL HOLE VWW397 D ELM= CU RESULT= 0.05
 HIS 0.05 0.07
 SHEET# 8621101 LAB# 604956 DRILL HOLE VWW397 D ELM= ZN RESULT= 0.06
 HIS 0.06 0.03
 SHEET# 8621101 LAB# 604956 DRILL HOLE VWW397 D ELM= AG RESULT= 0.01
 HIS 0.01 0.01
 SHEET# 8621101 LAB# 604956 DRILL HOLE VWW397 D ELM= SE RESULT= 0.004
 HIS 0.004 0.004
 SHEET# 8621101 LAB# 604956 DRILL HOLE VWW397 D ELM= BE RESULT= 0.005
 HIS 0.005
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= NA RESULT= 53.
 HIS 53. 84 70
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= CA RESULT= 160.
 HIS 160. 185 136
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= MG RESULT= 36.
 HIS 36. 48 40
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= K RESULT= 4.0
 HIS 4.0
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= F RESULT= 0.10
 HIS 0.10
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= NO3-N RESULT= 3.88
 HIS 3.88 3.03 2.14
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= SO4 RESULT= 124
 HIS 124 113 121
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= PHOH RESULT= .01
 HIS .01 .01 .01
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= ALK RESULT= 242
 HIS 242
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= HD RESULT= 390
 HIS 390
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= PH RESULT= 7.5
 HIS 7.5 7.6 7.5
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= COND RESULT= 1400
 HIS 1400 1500 1425
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= TOC RESULT= 5.3
 HIS 5.3
 SHEET# 8621101 LAB# 604957 DRILL HOLE VWW398 T ELM= TDS RESULT= 933

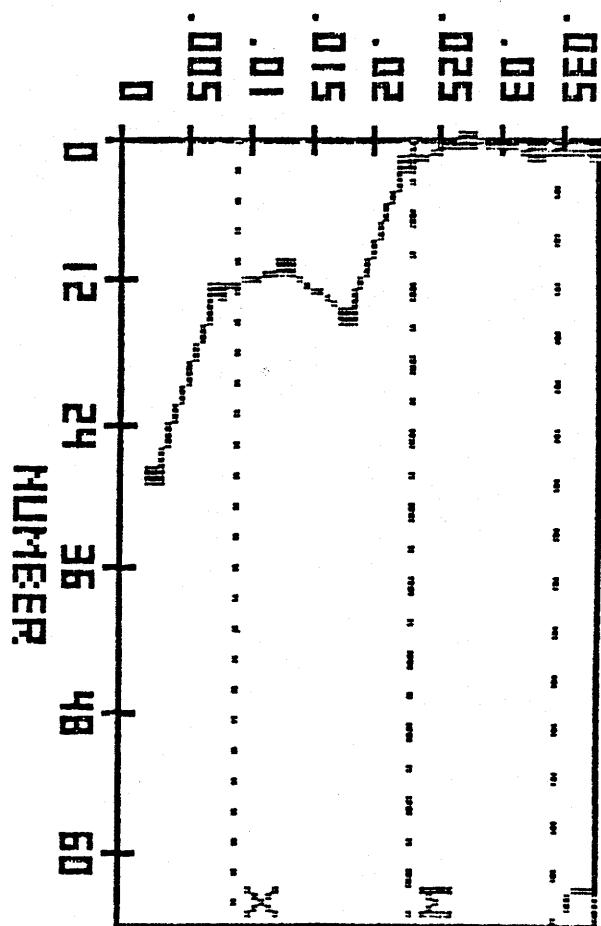
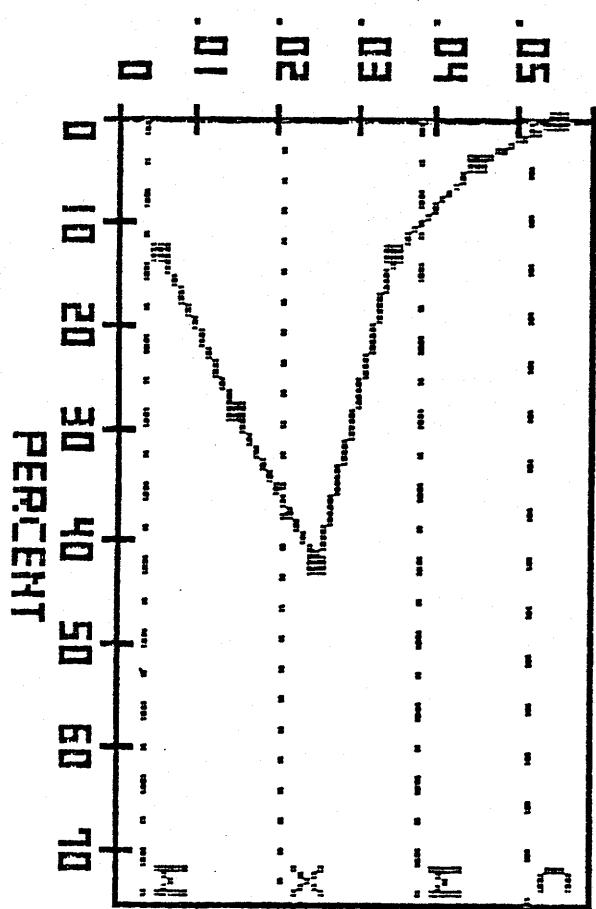
MG/L SE FOUND



MG/L DIFFERENCE

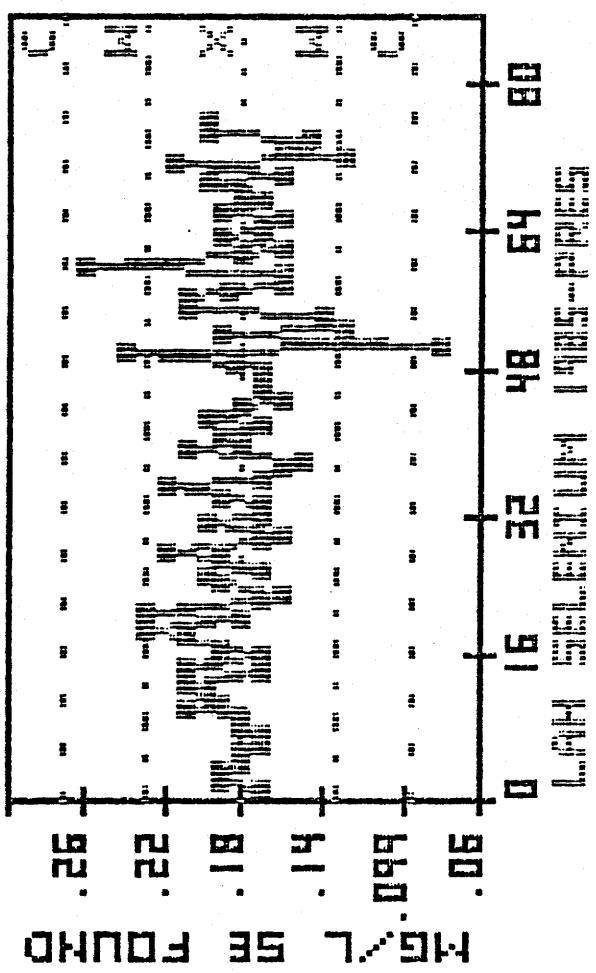
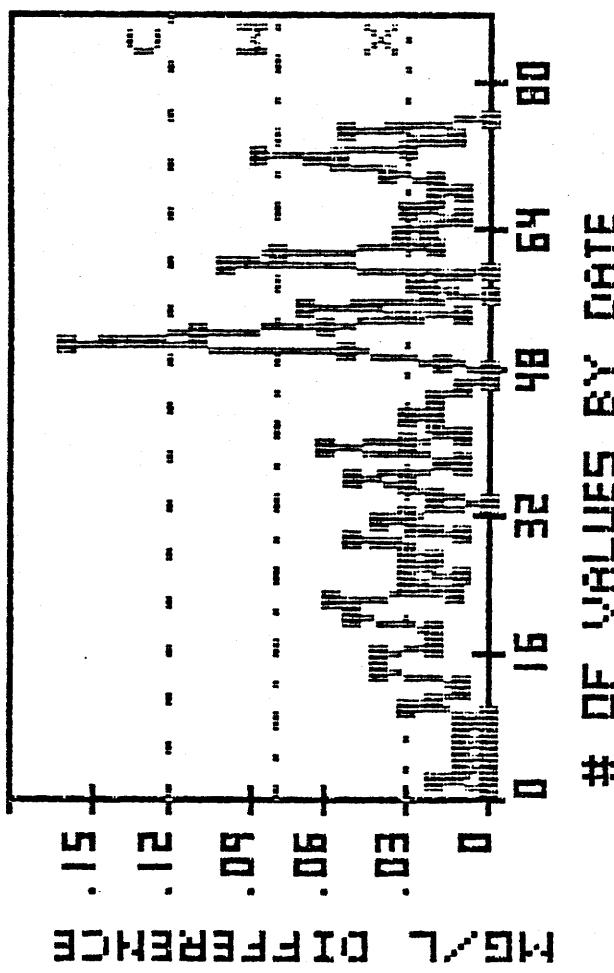
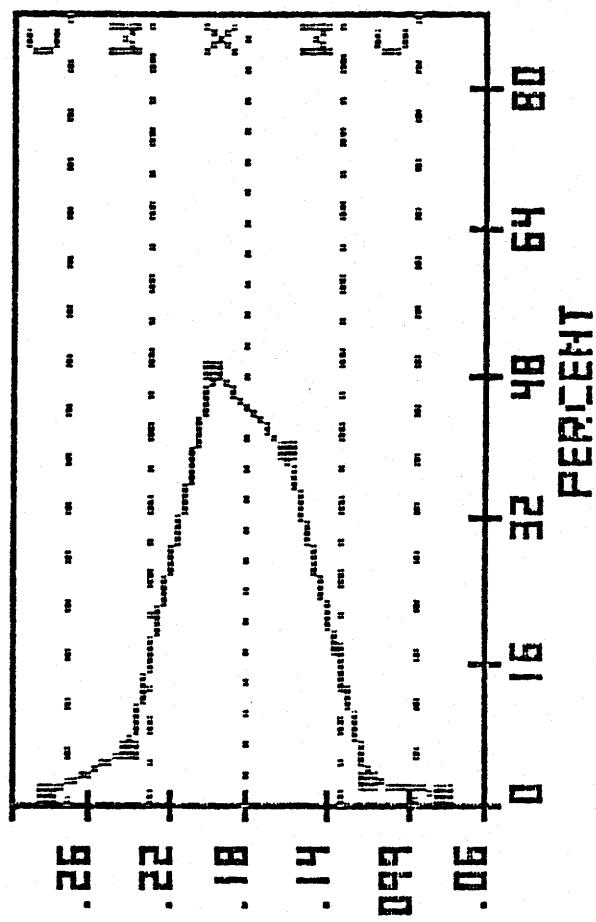
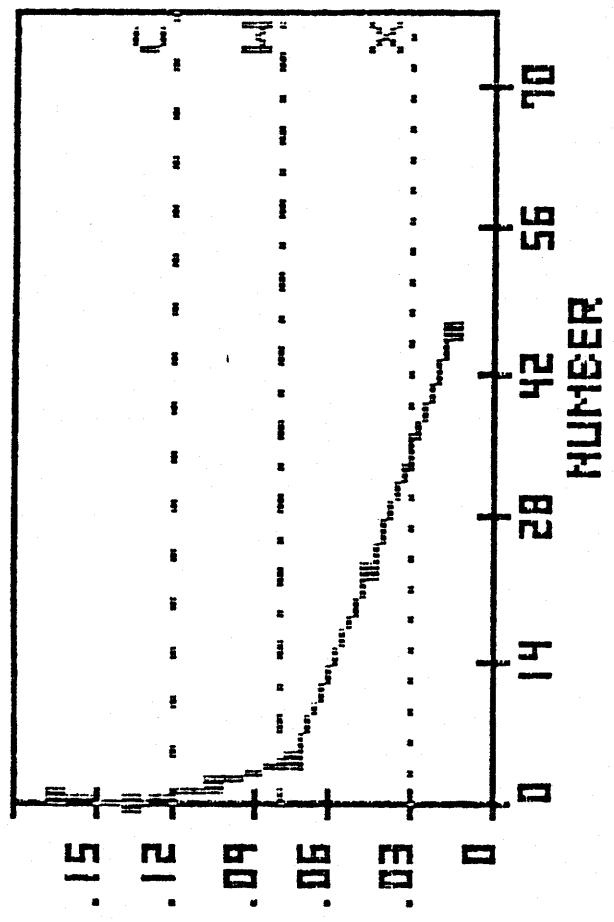


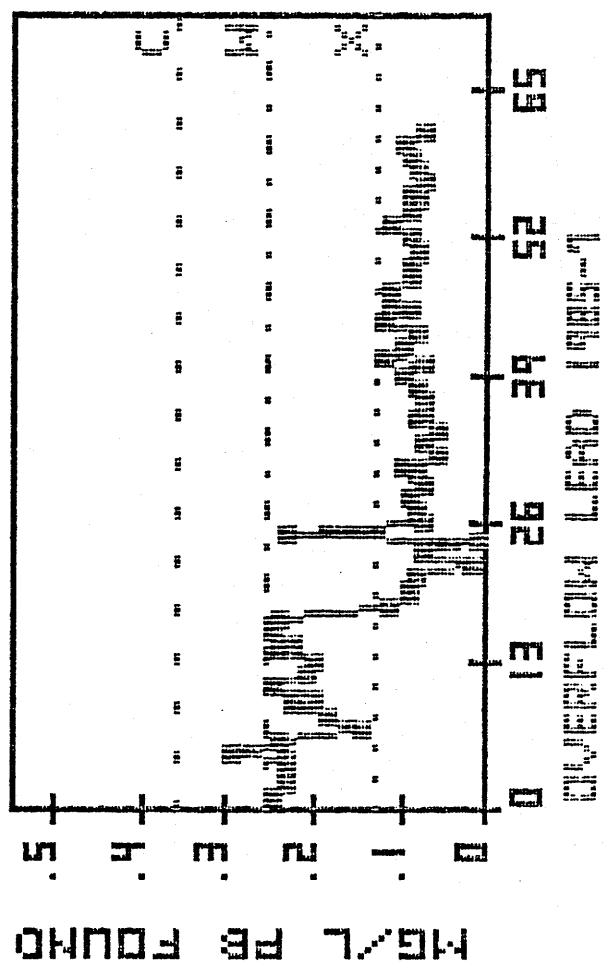
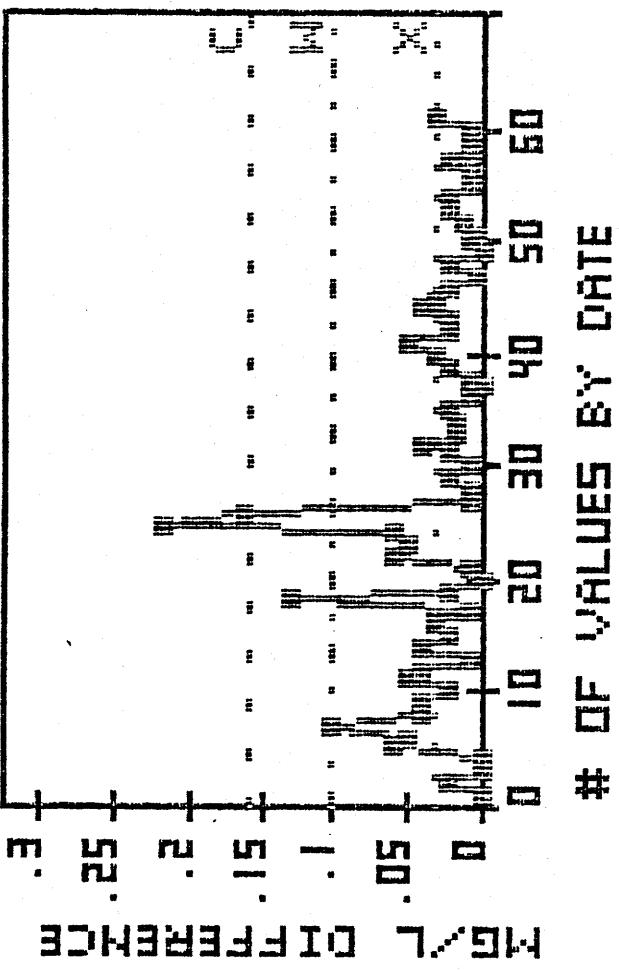
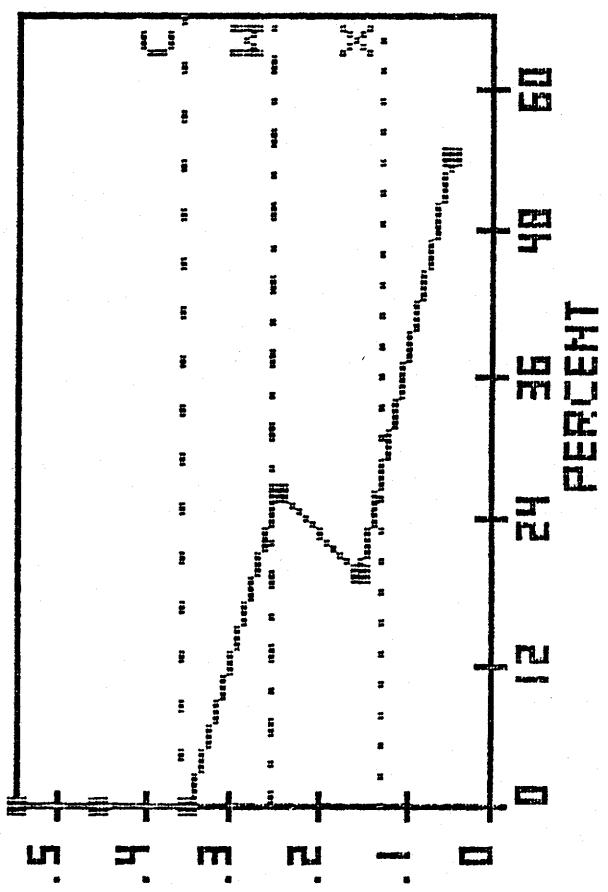
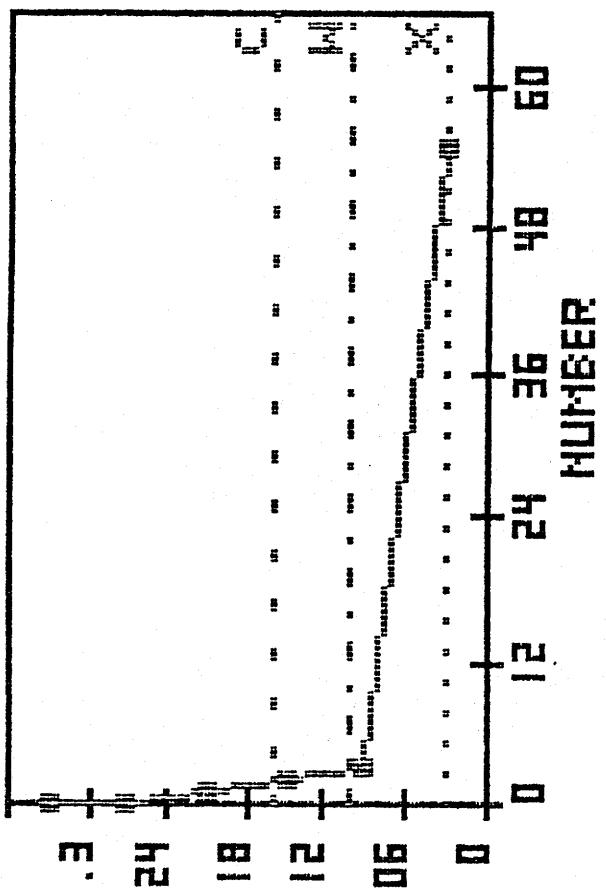
OF VALUES BY DATE

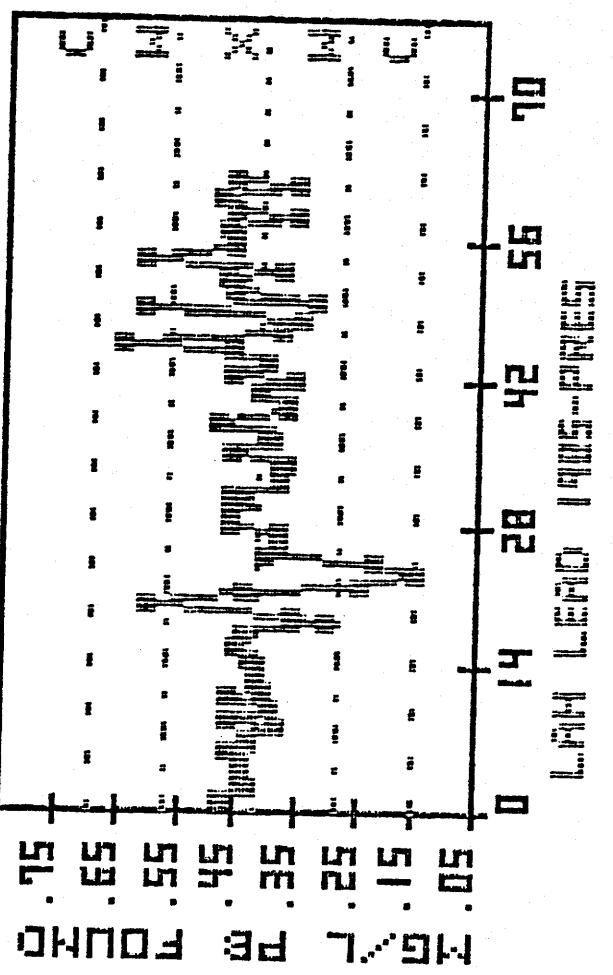
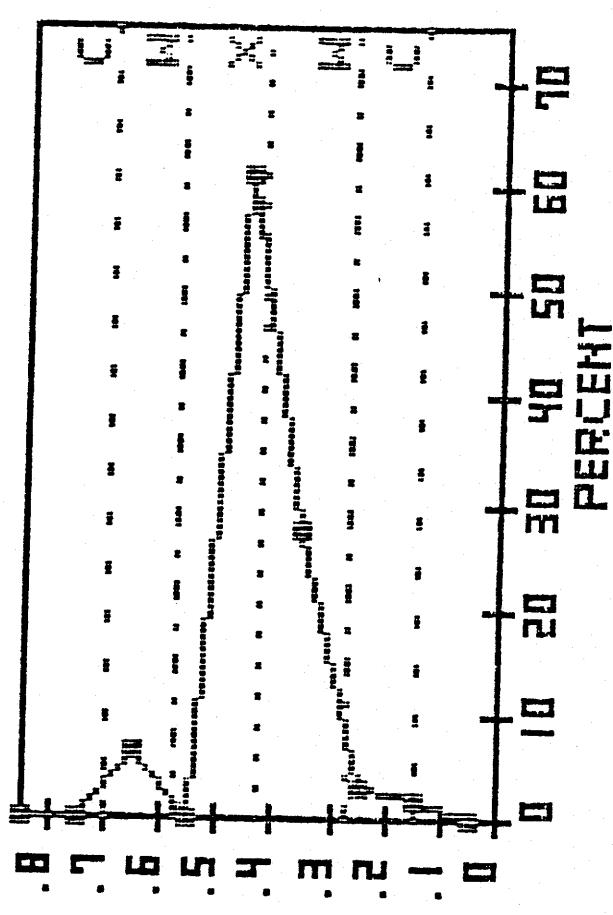
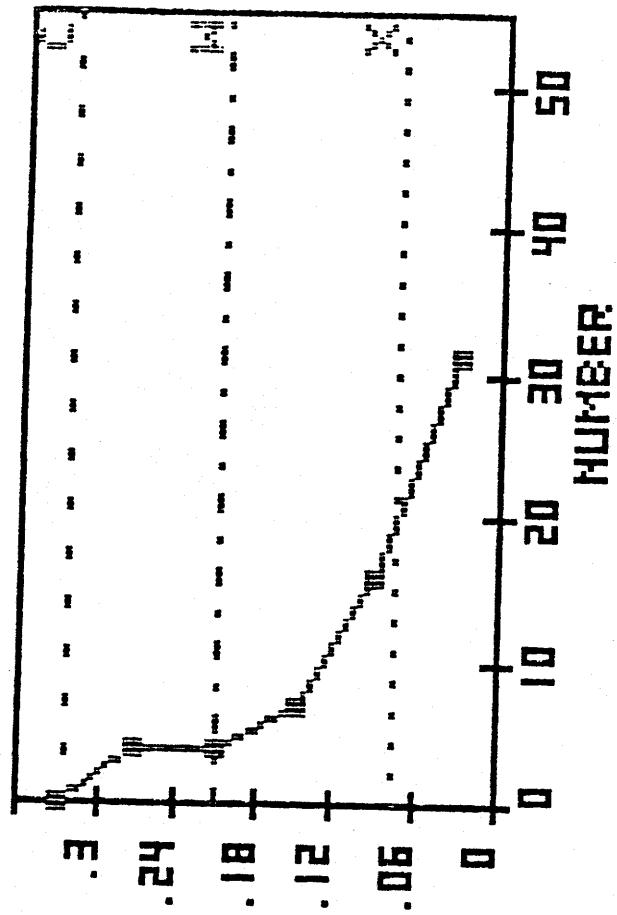
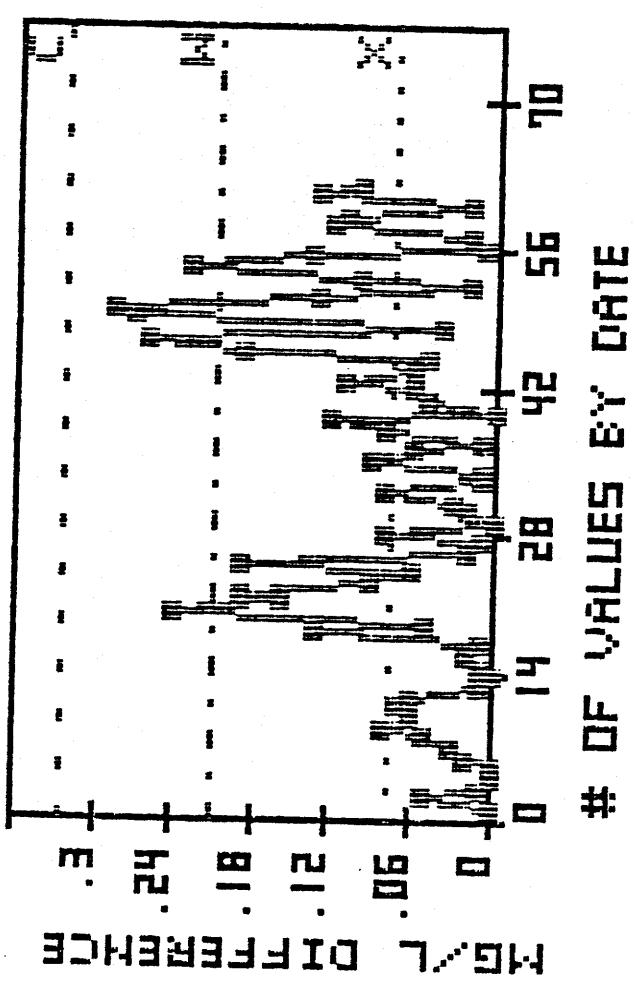


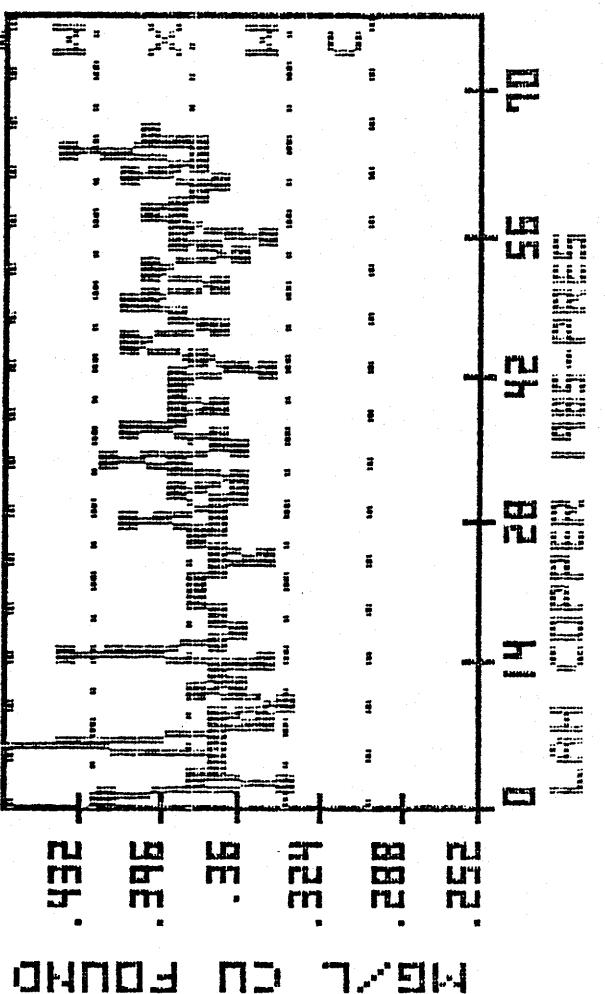
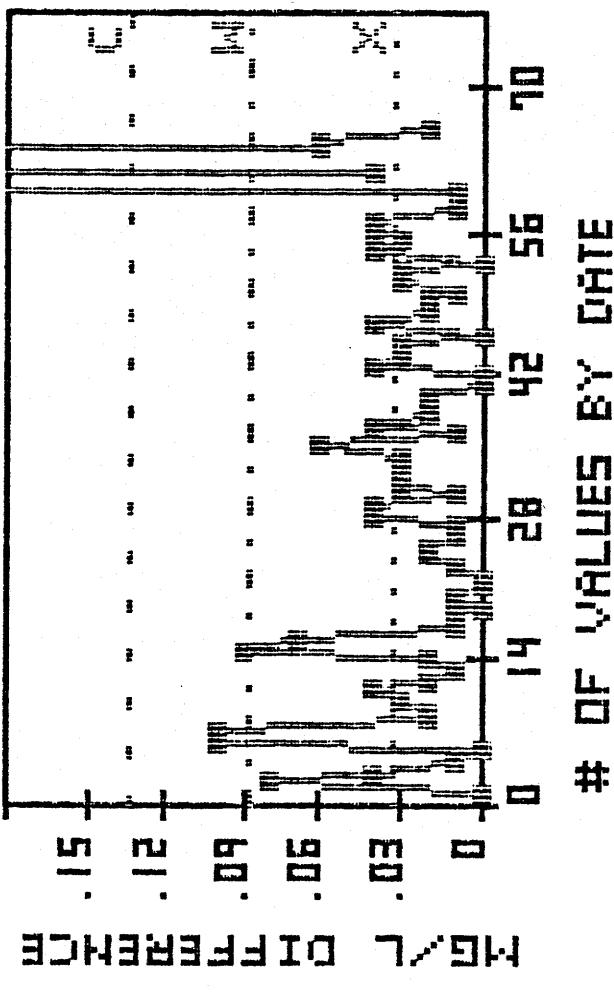
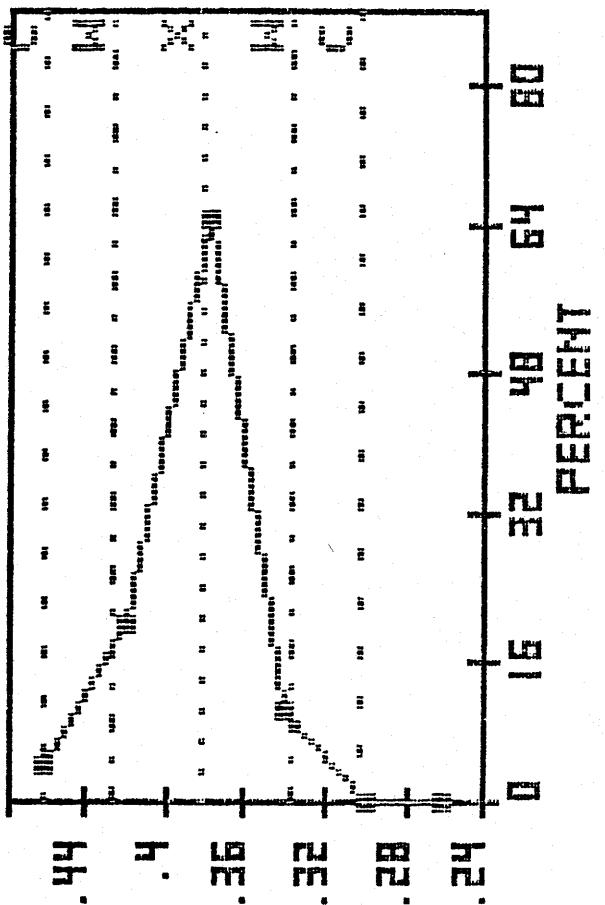
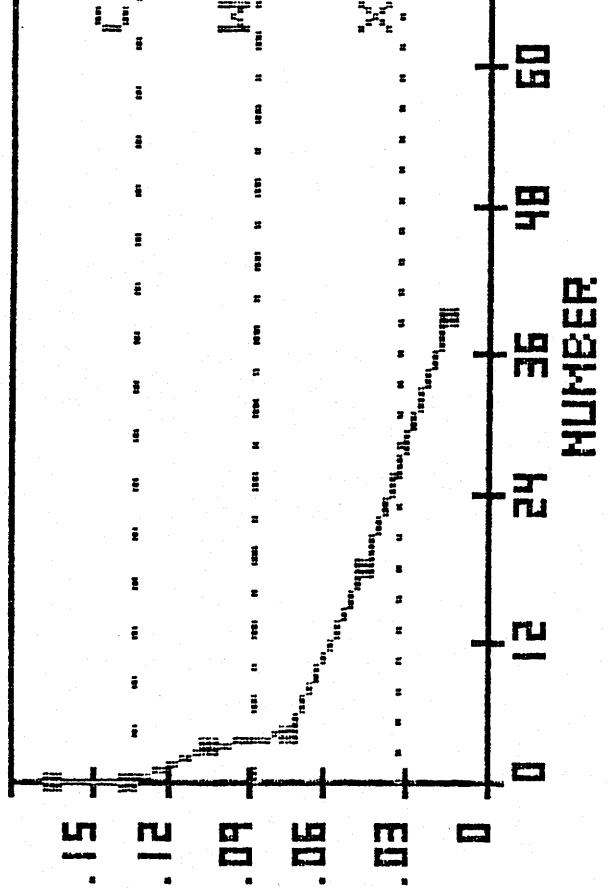
CUMULATIVE SELLER LEVEL (mg/l)

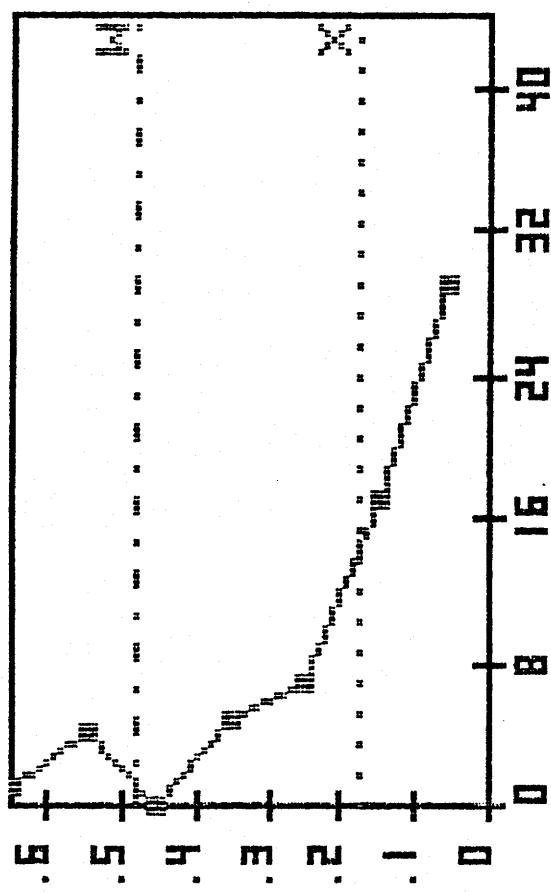
PERCENT



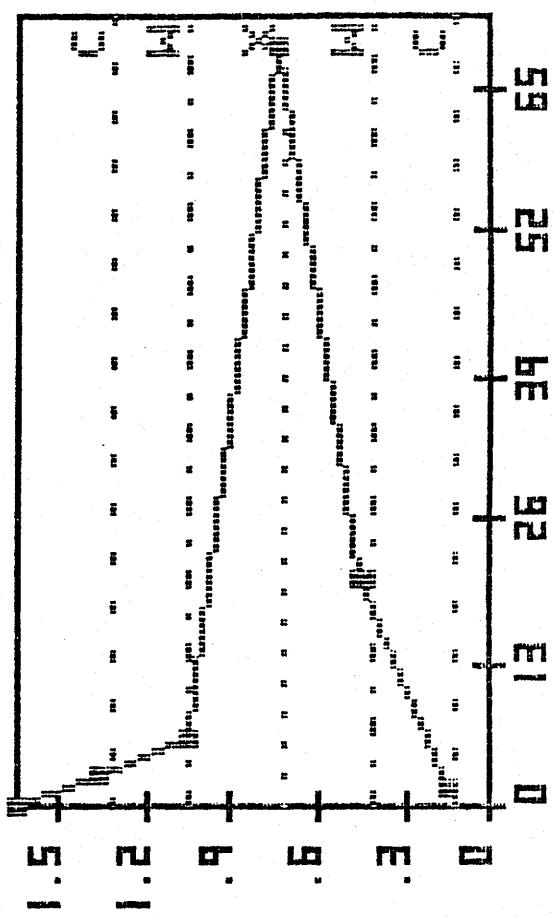




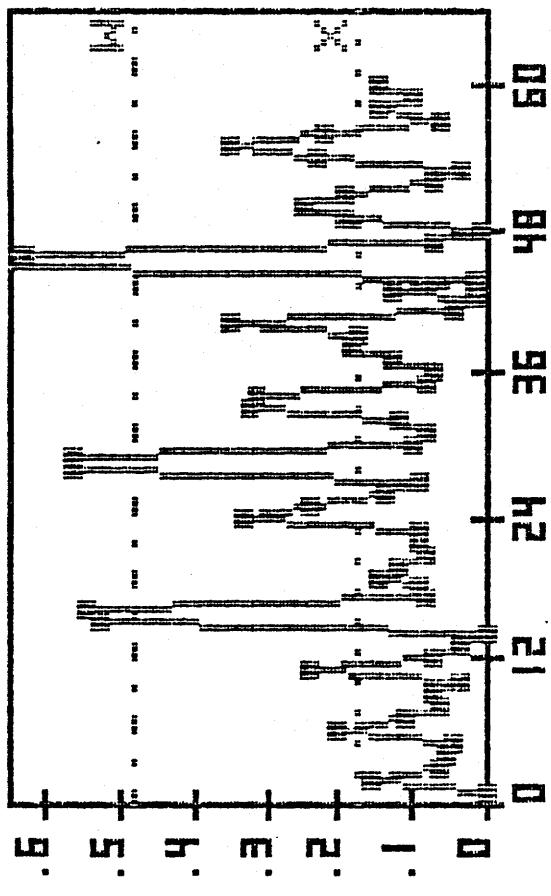




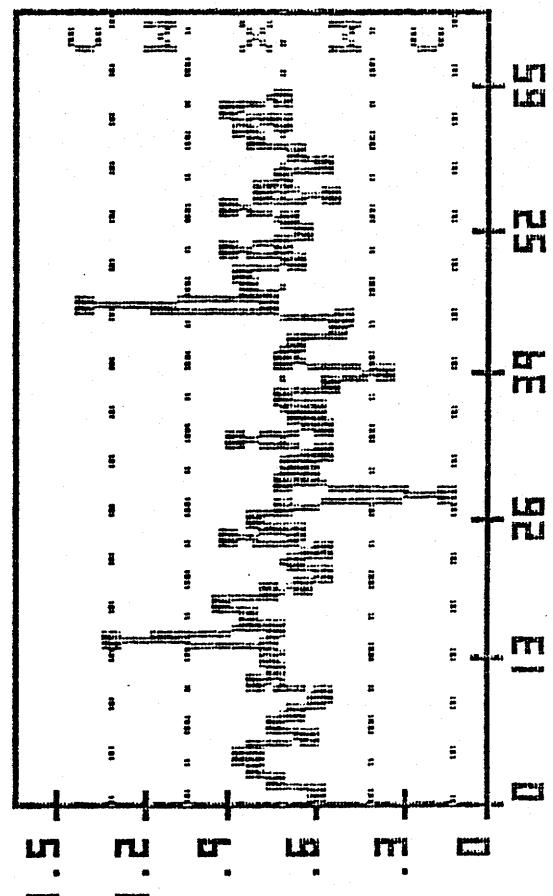
HUMMER



PERCENT

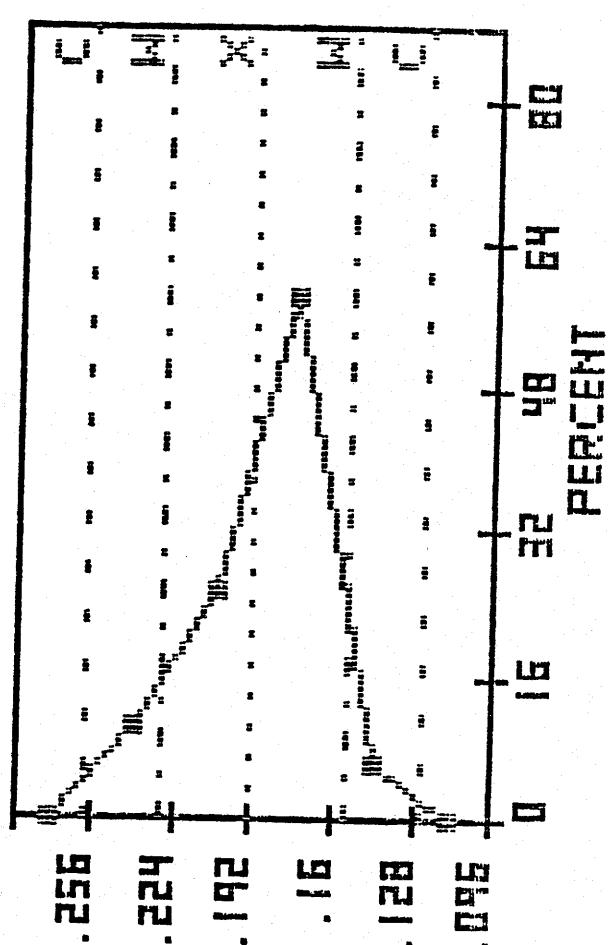
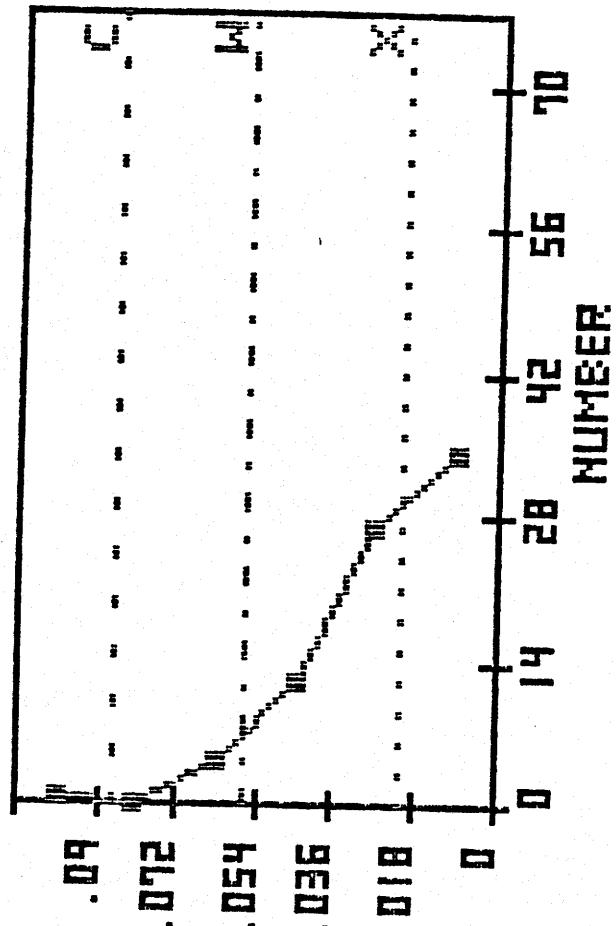
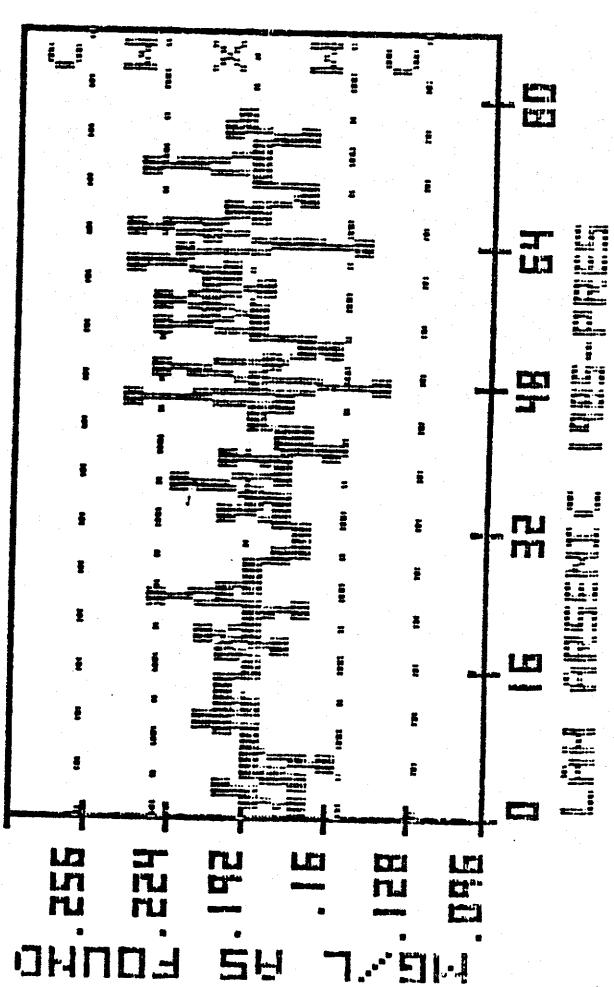
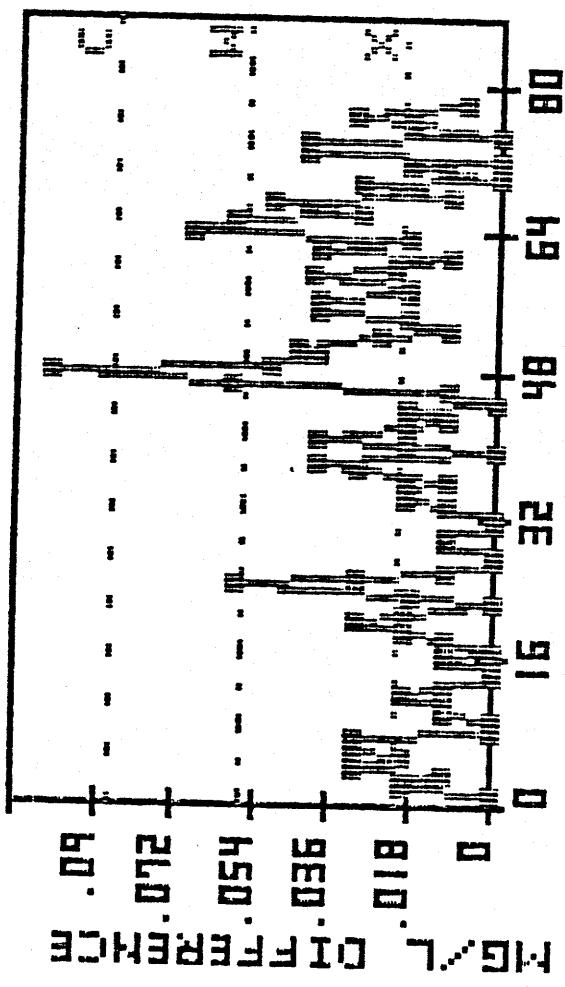


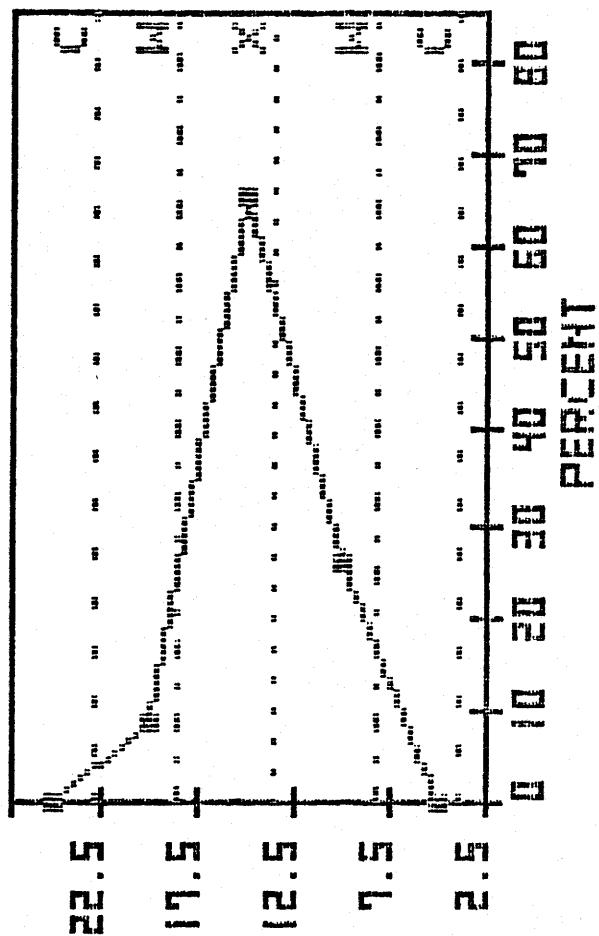
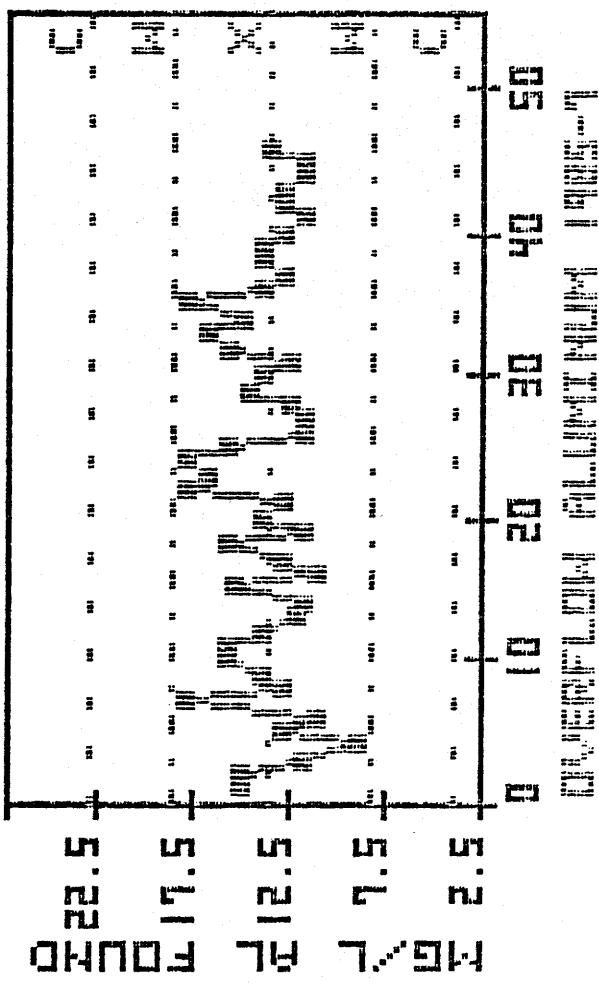
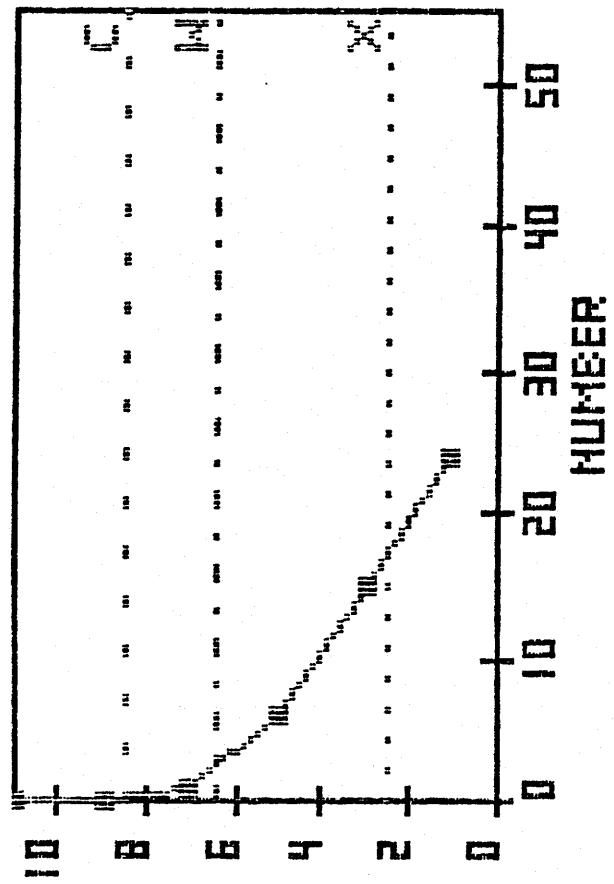
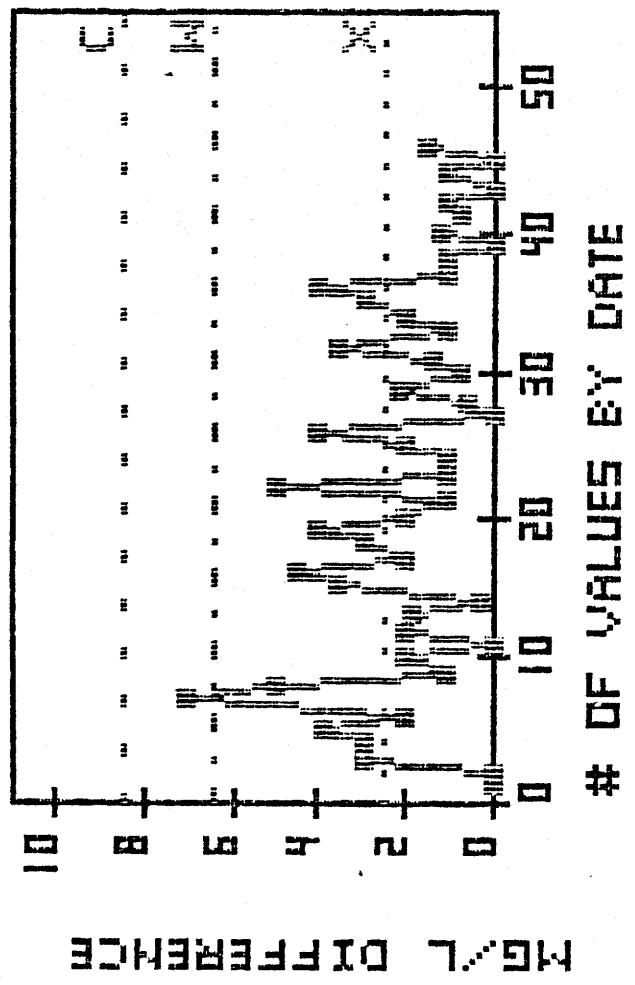
MG/L DIFFERENCE

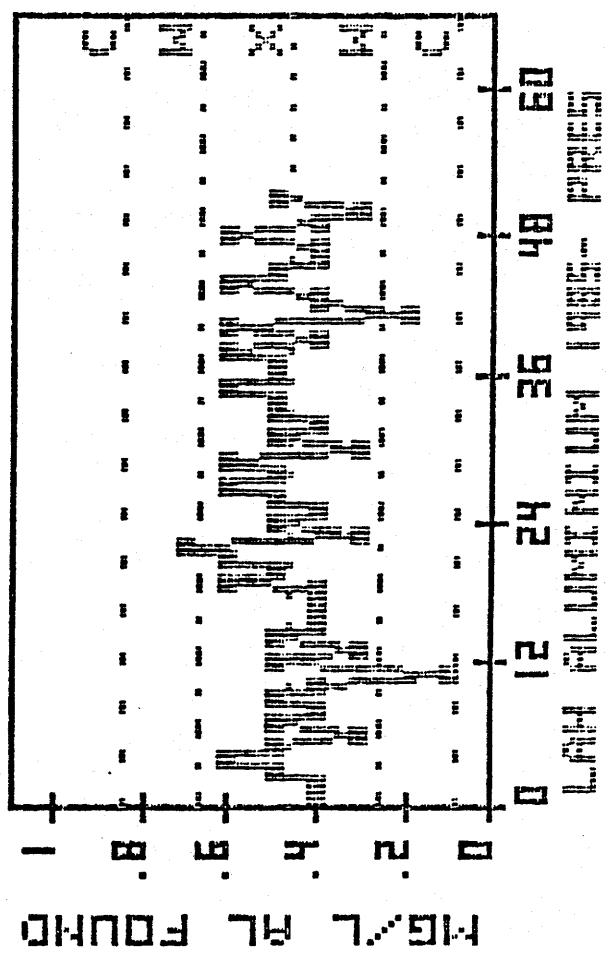
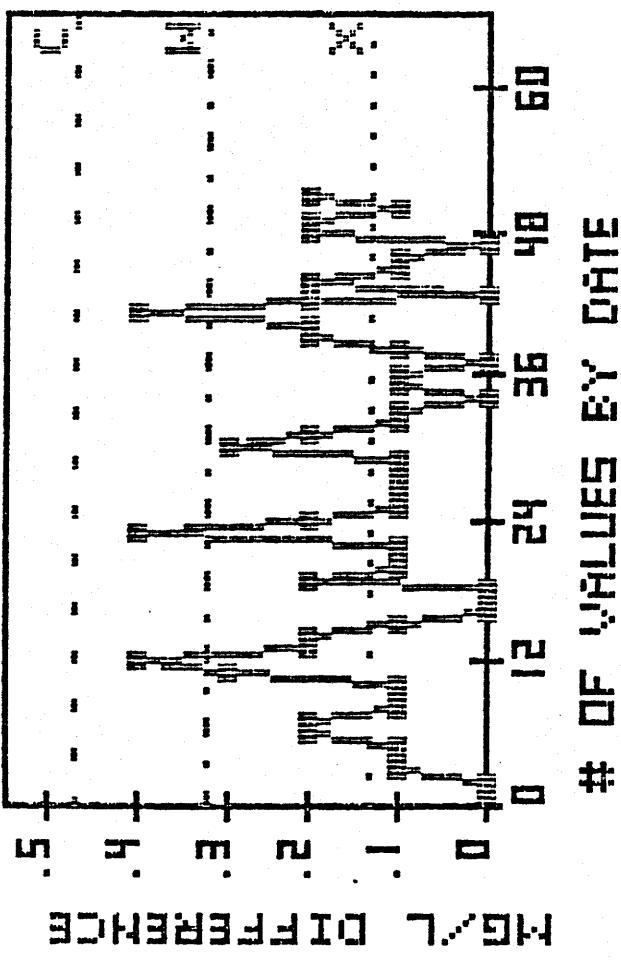
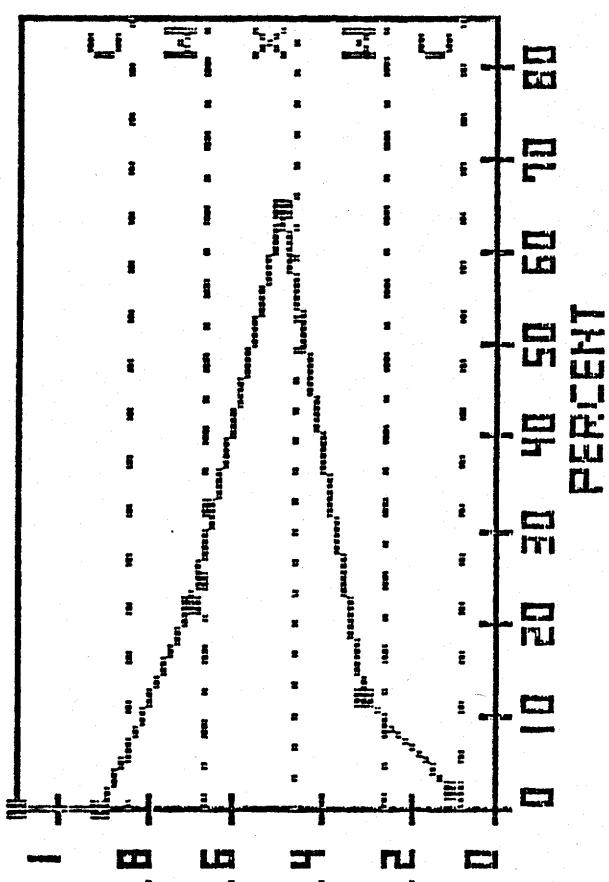
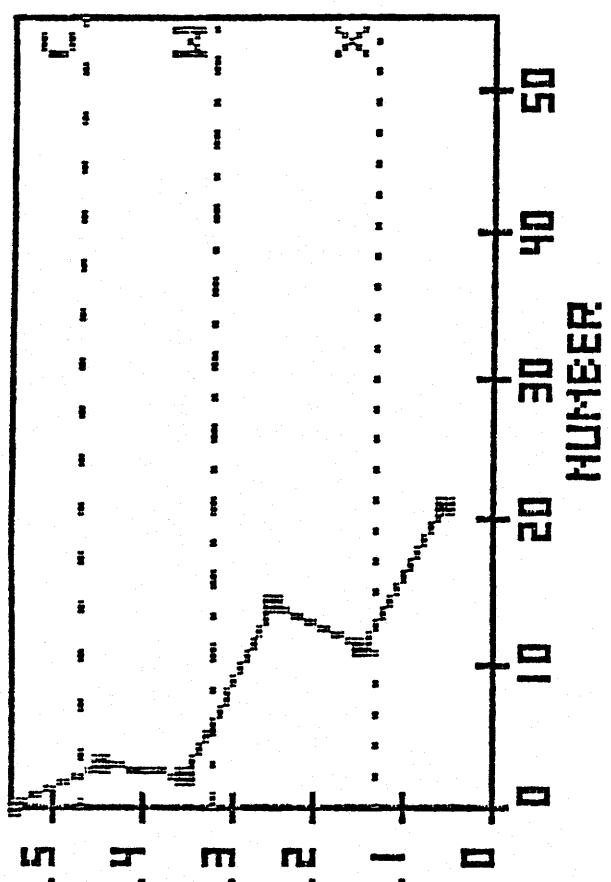


MG/L AS FOUND

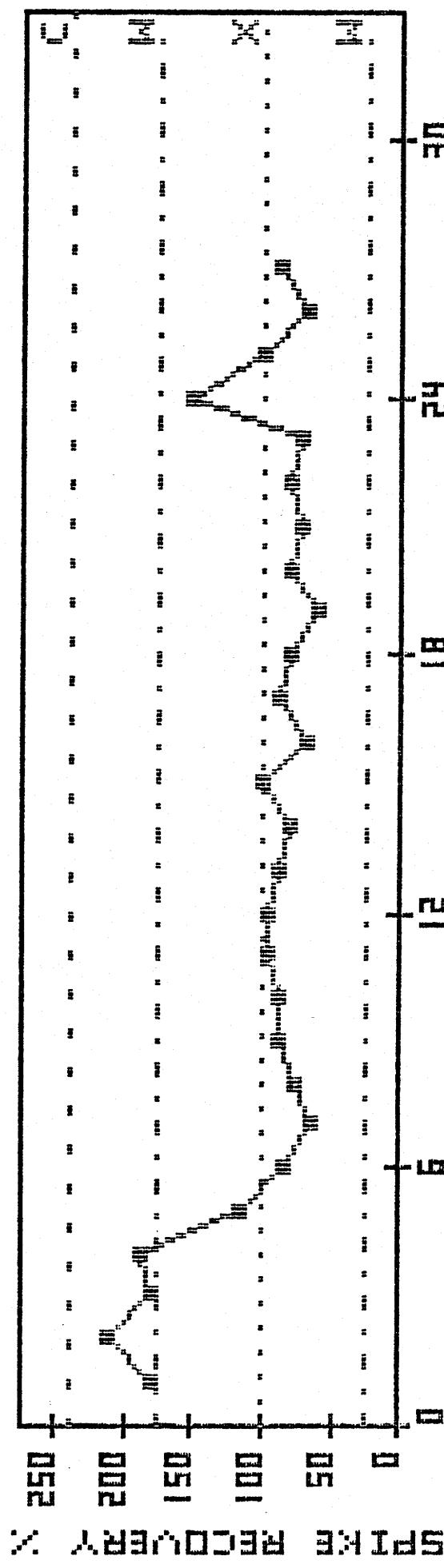
CULVERT/DRIVE ELEMENT HUMMER







WATERFALL PLOT



30

NUMBER OF ENTRIES IN CHRONOLOGICAL ORDER

5

10

15

20

25

30

35

40

45

50

55

60

65

70

75

80

85

90

95

100

105

110

115

120

125

130

135

140

145

150

155

160

165

170

175

180

185

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255

SPIKE RECOVERY X